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BUFFALO, N. Y. **JUNE 16th to 20th, 1930**

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THE IRON AND STEEL INDUSTRY INVITED

EDITORIAL

To the Chief Engineers,
To the Rolling Mill Superintendents,
To the Electrical Engineers,
To All the Interested Operating Executives,
Iron and Steel Industry,
United States and Canada.

You are earnestly solicited to co-operate with the Association of Iron and Steel Electrical Engineers in filling out the following questionnaire, covering the use of Anti-Friction Bearings for Roll Necks. The Association has for the past three years, devoted considerable time and study to the use of this particular type of bearing for Roll Necks and the Special Committee on Bearings will devote all of their activities during 1930 and 1931 to the subject.

Many of the Iron and Steel Plants have offered their services to make this study complete and of material value to the industry.

Please forward the questionnaire to:

Special Committee on Bearings,
Association of Iron and Steel Electrical Engineers,
1010 Empire Bldg., Pittsburgh, Pa.

1. Have you any mills in which the rolls are equipped with anti-friction bearings? Yes_____ No_____.
2. Have you any mills in which the rolls were equipped with anti-friction bearings and which were changed back to plain bearings? If so, state reasons.
3. Are the rolls which are equipped with anti-friction bearings, driven,_____ friction?_____
4. Are these rolls which are equipped with anti-friction bearings used for rolling Hot_____ Cold_____ Stock? What type of mills, Sheet, Bar, Merchant, Plate, Skelp, Rail, Structural or Strip?
5. Are they 2 High,_____ 3 High,_____ 4 High,_____ Cluster,_____?
6. If they are backed-up mills such as 4 High or Cluster have they anti-friction bearings on working rolls,_____ supporting rolls,_____?
7. Is the service continuous,_____ intermittent,_____?
8. What are the roll diameters,_____ speed of the rolls, RPM_____?
9. What are the neck diameters_____?
10. Width of stock roll, maximum_____ average_____?
11. Minimum gauge of stock roll_____?
12. What is the approximate temperature of product finished?
13. Are roll necks equipped with anti-friction bearings, cylindrical or tapered?
14. Reduction per pass expressed in per cent maximum _____ minimum_____ rpm_____?
15. Do you lubricate with grease,_____ oil,_____ sight feed,_____ pressure feed,_____ periodic,_____?
16. In your judgment do you consider that there is any power saved on anti-friction bearing equipped mills as compared to plain bearing equipped mills_____?
17. Any determination of power savings? Yes_____ No_____.
18. What troubles have you experienced in keeping foreign matter out of anti-friction bearings?
19. Do you consider the lubrication of anti-friction bearings as compared to plain bearings to be as simple? Yes_____, No_____, Also as effective?_____ Yes_____, No_____
20. If oil lubrication is used; is it advisable to keep your anti-friction bearing lubrication system separate from the lubrication on driving motors, etc?
21. Have you experienced any breakage of necks traceable to reduction in neck diameter to accommodate anti-friction bearings? Yes_____, No_____.
22. In case a roll equipped with anti-friction bearings is broken, how much trouble and expense is involved in changing rolls?
23. Do you consider it an advantage that anti-friction bearing housings do not have to be water cooled. Yes_____, No_____.
24. In hot rolling the heat is dissipated by conduction through the necks to the bearings, then to the housings. Does this have any effect on the bearings?
25. From your experience how does the service of anti-friction bearings compare with plain bearings? Better_____, Equal_____, Not as Good_____.
26. Have you experienced any troubles due to end thrust?
27. Assuming that the wear on an anti-friction bearing is negligible, what importance do you attach to the resulting characteristic which makes it unnecessary to adjust draft, once the desired thickness has been established_____?
28. Have you noticed any difference in the heating of the roll necks between anti-friction bearing mills and plain bearing mills in the operation of the mill_____?
29. Is it not possible to reduce roll neck diameters on anti-friction bearing mills as compared to plain bearings because the width of the anti-friction bearing is less and consequently can be brought closer to the body of the roll, thereby reducing bending moment_____?
30. Some types of Anti-Friction bearings make it necessary to mount the inner race with a press fit on neck. To what extent do you consider this a disadvantage from operating standpoint_____?

31a. Realizing that the maximum external dimensions of an anti-friction bearing are limited on the outside diameter by the diameter of the roll and on the bore by the diameter of the neck, the successful period of service which an anti-friction bearing can give can be definitely defined as based upon the prevailing average load and RPM. Under the circumstances, what period of time, in your judgment, would be commercial and justified from the use of anti-friction bearings instead of plain bearings? In other words, express this in a period of time based upon continuous service, 24 hours per day, 7 days per week.

31b. For example, if you were able to obtain 18 months to two years continuous service from a set of anti-friction bearings, would you consider that interval of time as commercial_____?

32. When did you put in operation your first mill equipped with anti-friction bearings? Month_____, Year_____.
33. In your opinion and experience what period of time would it require to return the investment of anti-friction bearings against plain bearings when considering any power savings or improved rolling practice? Years_____?

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Crane Track Wheels and Crane Runways†

By R. J. HARRY*

EDITORS NOTE—In the preparation and presentation of this paper the Association of Iron and Steel Electrical Engineers feel that the author, Mr. R. J. Harry, has made a most valuable contribution to the transactions of this Society as well as a most timely recommendation for the improved operation of Electric Overhead Traveling Cranes to the entire Industrial Field in America. When it is taken into consideration that any plant, large or small, may reduce their operating costs through the use of the author's recommendations and data, without purchasing any additional equipment, simply using the machine tools which every shop possesses, the Association agrees as well as every other operating executive that Mr. Harry must be complimented and congratulated on his efforts in all industries behalf.

I have been asked to present a paper this afternoon on the subject of crane track wheels and crane runways. In crane maintenance work, such as obtains in the modern steel mills, there is probably no single item on which as much money is spent as the crane track wheel. It would, therefore, be well to review some of the common grievances encountered daily by the maintenance men to give us a good background for this discussion.

R. J. HARRY

The first cranes installed in the steel mills were equipped with cast iron track wheels. These wheels had a hard wearing surface and in that respect were desirable. However, their inability to withstand shock and the severe stresses occasioned by crane twist resulted in too frequent breakage and led to their abandonment in favor of the cast steel wheel.

The cast steel wheel was a step forward as far as breakage was concerned, but the excessive wear and cutting of the flanges, due to the rail being much harder than the wheel, led to the development of the cast alloy steel track wheel.

The desire for a stronger wheel having better wearing properties and longer life under the most severe operating conditions led first to the development of the rolled steel wheel of high carbon content, and then to the extremely hard heat treated rolled steel track wheel.

While the metallurgists were busy with the development of an ideal steel from which to make track wheels, the engineers were likewise busy trying to solve the operating problems encountered in the field. If the driving track wheels could be kept at exactly the same diameter, runways maintained perfectly level, and in perfect alignment and span, lubricants prevented from getting on the rails causing unequal slippage of the track wheels on opposite ends of the crane and water prevented from getting on the track creating a condition where one track would be dry and the other track wet and slippery, operating troubles would be a negligible consideration.

Since, however, the reverse of these ideal conditions exist either singly or combined, the operating man finds himself continually facing track wheel trouble, and where the extremely hard track wheels are installed he finds rail replacements are more frequent. The experience of many operators has been, that where extremely hard track wheels have been installed to secure longer life of the track wheel,

†Presented before Pittsburgh District Section January 16, 1930.

*Asst. Elec. Supt., Carnegie Steel Co., Munhall, Pa.

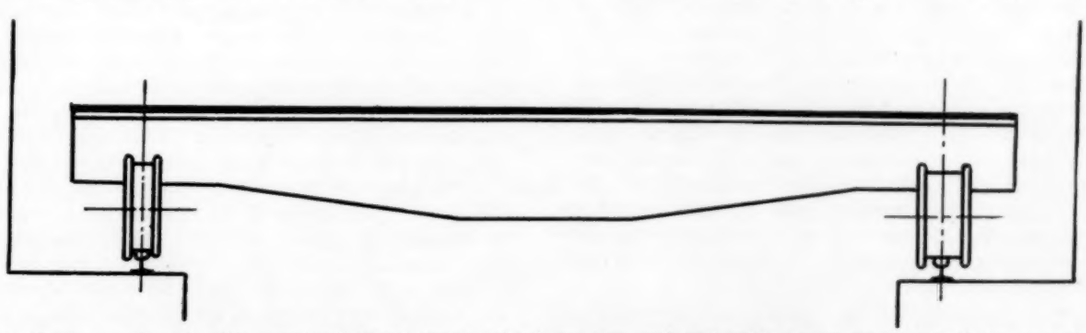


FIG. 1—Crane equipped with standard tread track wheel on one end and wide tread track wheel on opposite end.

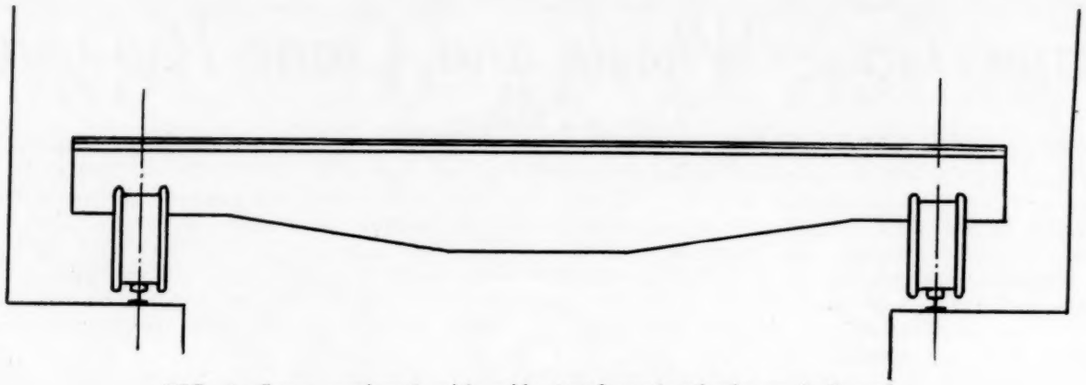


FIG. 2—Crane equipped with wide tread track wheels on both ends.

that goal had only been attained at the expense of a relatively short life of the rail.

Some years ago a few cranes were built in which the wheels on one end of the crane had the standard clearance between the head of rail and the flanges of the track wheel, while the other end of the crane was equipped with wheels which supplied extra clearance between the flanges of the track wheel and the head of the rail. Fig. 1. The idea of this scheme was to permit free running of the crane even though there were slight variations in the span of the runway. This scheme did not give the desired results as the diameter of the narrow tread wheel decreased much more rapidly than that of the wide tread wheel and consequently it was not long before the crane was traveling in a circle of large radius due to the unequal diameters of the driving track wheels. This naturally resulted in excessive wear of the track wheel flanges and the sides of the rail head. In some cases cranes were known to jump the track.

This construction was employed on several cranes installed at the Howard Axle Works in 1899 and on some cranes at the Carrie Furnaces.

A later development was the employment of wide tread track wheels on both ends of the crane as shown in Fig. 2. It was thought that this would compensate for slight inequalities of the crane span and misalignment of the runway. However, it developed that when the wear on the tread of the driving track wheels was not uniform the crane twisted with the same results as experienced in the previous case. Furthermore, when the crane twisted it remained in a twist until it was run down to the end of the runway and bumped into the bumping blocks a sufficient number of times to square it up.

Track wheels were also made with standard tread clearance and provision for a great amount of end play between the flanges of the bearings and the hubs of the track wheel. Fig. 3. This scheme met some of the objections of the earlier schemes inasmuch as it provided for uniform wear of the wheels and took care of slight variations in the crane span and misalignment of the runway rails. However, the great amount of end play brought about a condition of uneven wear of the journals and the gearing and provided no means of squaring up the crane on the runway once it became twisted. Consequently, it did not produce the desired results.

None of the schemes tried provided any means for removing the twist from a crane bridge, which usually results from unequal slippage due to one side of the runway being wet or greasy, or to handling heavy loads on one end of the crane. It, therefore, became necessary to periodically run the crane to the end of the runway and straighten it up against the bumping blocks.

The use of sanders conveniently operated from the cab helped to overcome the slippery rail condition, but did nothing to square up the crane once it got out of alignment.

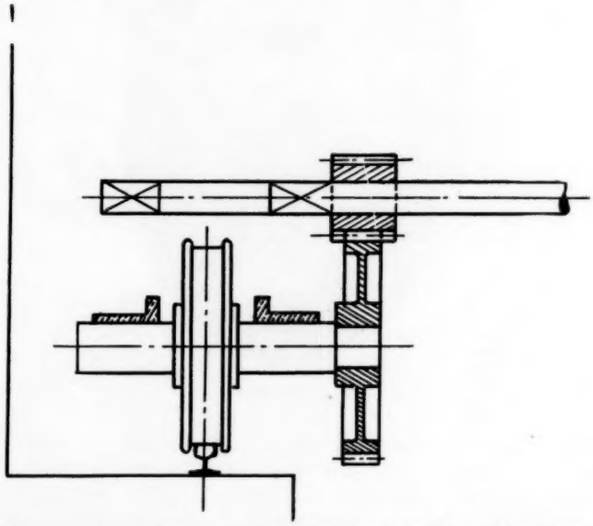


FIG. 3—Crane equipped with standard tread track wheels and extra clearance between the flanges of the bearings and the track wheel hub.

A few years ago we experienced so much trouble with track wheels and rails on three of our cranes on a runway 70 feet span and 1200 feet long that it was necessary to find some solution to the problem. The trouble referred to above resulted entirely from crane twist. We thought at first that a cure could be brought about by making the driving track wheels exactly the same diameter. This was done, but the shearing off and breaking of rail clamp bolts and excessive wear on the wheel flanges and rail heads still continued. On several occasions these cranes actually jumped the track and on more than one occasion disaster was narrowly averted.

It was at this time that the writer decided to try out the tapered tread double flanged track wheel. For this experiment we used a set of old track wheels

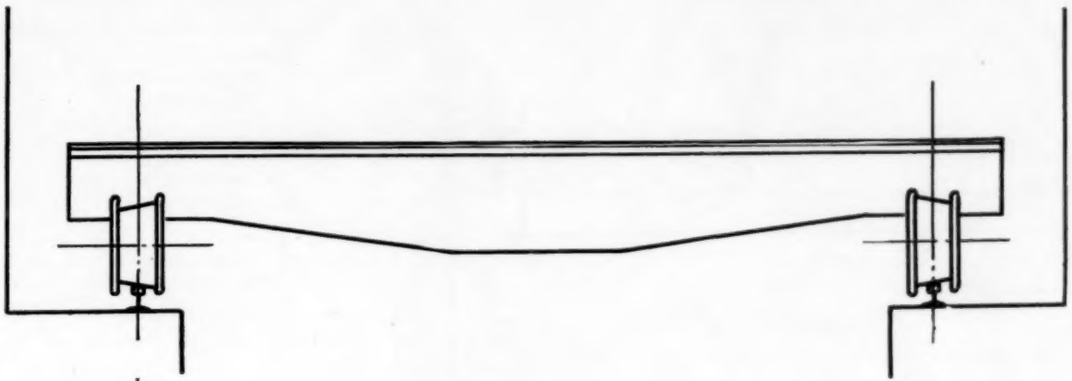


FIG. 4—Elevation of crane equipped with taper tread driving track wheels.

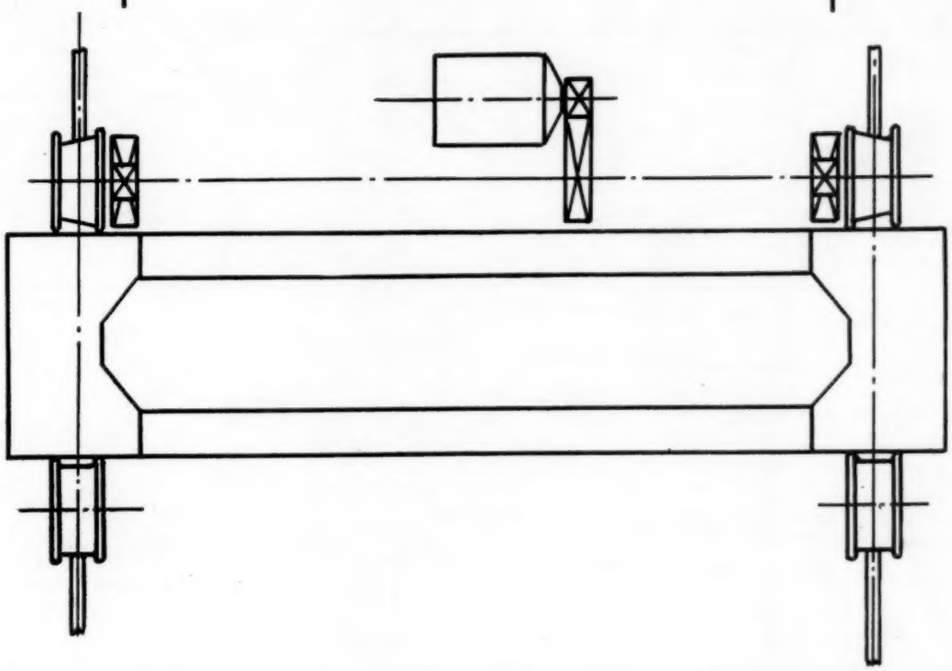


FIG. 5—Plan view of crane equipped with taper tread driving track wheels and straight tread follower track wheels.

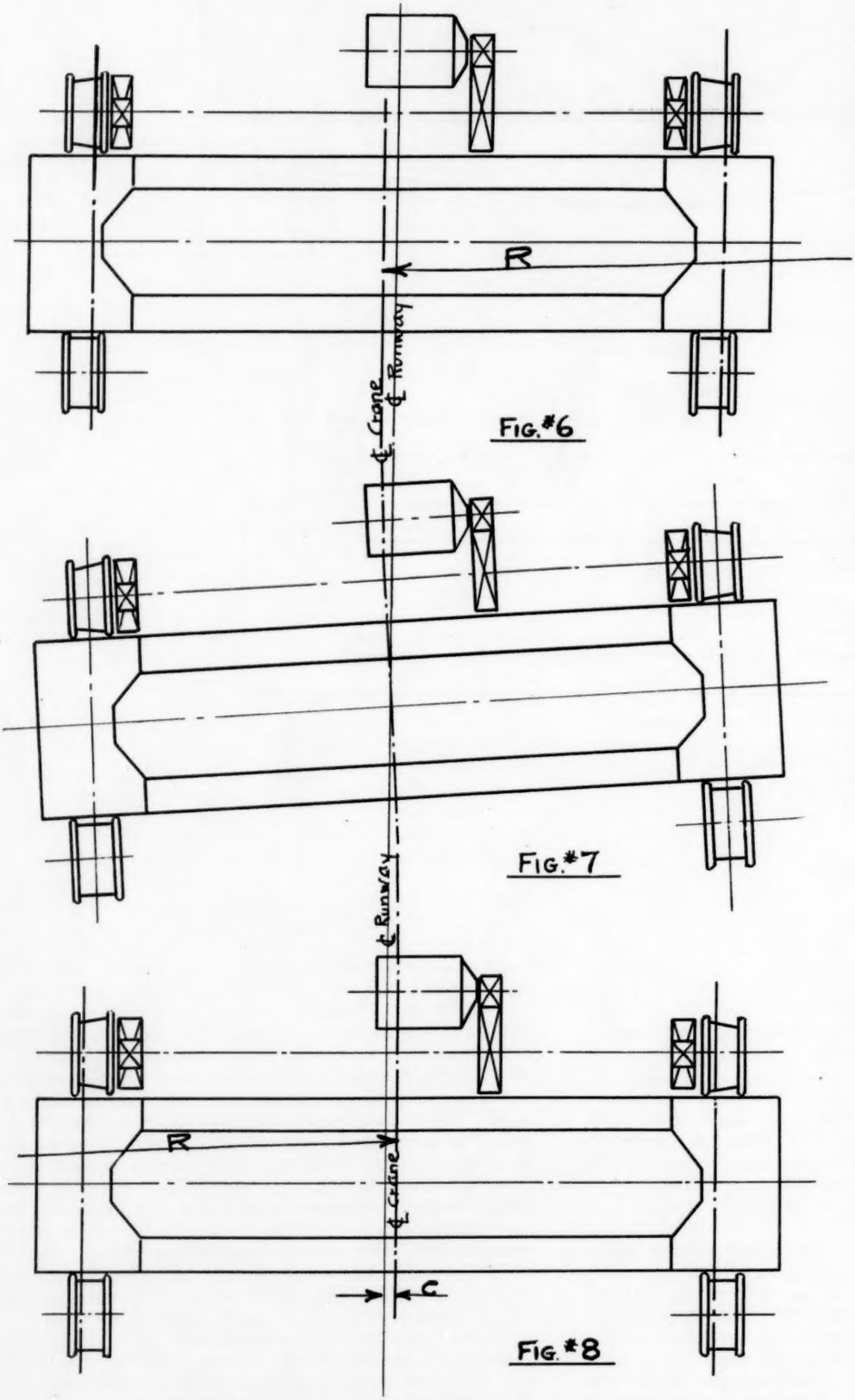
whose flanges were worn so thin as to make them unsafe for further use with straight treads. We tapered the treads so that the large diameter of the tapered tread was toward the center of the crane and the small diameter on the outside as shown in Fig. 4 and 5. On account of the previous excessive flange wear the tread was very wide and provided more than the standard clearance between the flanges and the head of the rail. After these wheels were installed no further track wheel or rail trouble was experienced.

Most of the steel mill cranes are made very rigid and the girders held square with the end trucks by heavy gusset plates. It is almost impossible for the crane girders to get out of square with the end trucks. This gives the most satisfactory operating conditions as it prevents wear on the bolts which hold the girders to the end trucks and always keeps the line shaft pinion and track wheel gear in perfect alignment.

When these cranes are equipped with taper tread driving track wheels and the crane started down the runway square, with the wheels making contact with the rails at points of equal diameter, the crane will continue to run square. If, however, the crane gets into a twist, occasioned by slipping or any other causes the crane will weave as it travels along the runway. Fig. 6, 7 and 8 show this to an exaggerated scale. The maximum amount of this weaving is determined by the clearance between the head of the rail and the flanges of the wheel. It, therefore, follows that the greater the clearance or width of tread, the greater can be the angle of crane twist before the wheel flanges make contact with the rail head. This weaving of the wide tapered tread track wheel produces satisfactory results from the standpoint of wear, inasmuch as it distributes the wear over the entire surface of the tread. It has been observed under actual operating conditions that the maximum wear occurs at the center of the tread. This would seem to indicate that the crane track wheels are usually making contact at this point and would naturally lead to the conclusion that the crane under normal operating conditions does not weave very much, but usually runs square on the runway.

This is also borne out by the fact that under operating conditions practically no wear occurs on the wheel flanges or rails.

Since taper tread track wheels produce a free running crane, the bridge motor load is decreased and the wear and tear reduced to a minimum. It also follows, that if it is unnecessary to run the crane to the end of the runway to square it up by bumping it into the bumping blocks, longer life of the cranes and crane runways can be expected.



Assuming D = Mean diameter of track wheels in inches.

S = Bridge span in feet.

C = Distance between the center line of crane and center line of runway in inches.

R = Instantaneous radius of the crane at any point (in feet) and the slope of the tread of the track wheels is 1″ in 16″.

$$R = \frac{4DS}{C}$$

For example, in Fig. 6, assuming the following values:

D = 24″
S = 70′
C = 1″

Then $R = \frac{4 \times 24 \times 70}{1} =$ 6,720 feet.

In Fig. 7 we then have

D = 24″
S = 70′
C = 0″

and $R = \frac{4 \times 24 \times 70}{0} =$ infinity.

FIGS. 6, 7, 8—A plan view of an Electric Overhead Traveling Crane as it travels along the runway. The weaving action shown is due to the crane getting into a twist occasioned by slipping or any other causes.

The taper tread wheels also compensate for slight differences in the diameter of the driving track wheels, and under these conditions will permit of a free running bridge. This condition often arises where a pair of wheels are installed with equal diameter, but due to one wheel being softer than the other a slight difference in diameter occurs after the crane has been in operation.

It has also been found in practice that taper tread driving track wheels will overcome a condition where the track wheel axle bearings have been bored out of square with the end truck.

With straight tread wheels we have the following comparative data. If the crane is square and the diameters of the driving track wheels are exactly the same there is no tendency to twist. If, however, the crane does twist, due to slippery rails or other causes, it stays twisted and consequently wears out both track wheels and rails. Also, the slightest difference in diameter of the driving track wheels, causes the crane to twist and results in excessive wear as noted above.

It has also been found, especially where roller bearings have been used, that slight inaccuracies in machining the bearing housings have caused endless trouble and expense. The results obtained from the many installations of tapered tread track wheels, throughout the mill, on cranes of five tons capacity to 275 tons, convinced the writer that the use of extremely wide taper tread wheels would reduce flange and rail wear to a minimum. In order to check the results which might be obtained from the use of extra wide taper tread track wheels it was decided to experiment on the hardest worked overhead charging machine in our plant. This charging machine, incidentally is located on a very bad crane runway. After considerable deliberation and checking up of the clearances between the ends of the crane and the building columns, it was decided to make the distance between wheel flanges, or width of tread five inches. The width of the rail head was 2½ inches. This would permit a variation in crane span of 2½ inches plus or 2½ inches minus or a total of 5 inches. This charging machine was originally equipped with four equalizing trucks, eight straight tread track wheels having standard width of tread, brass journal bearings, and two bridge motors of 65 H.P. each. A two-year record of this machine showed that 20 special heat treated track wheels and 18 33-foot rails were worn out. During this same period we had several motor burnouts, broken end truck brackets and line shaft failures. We attributed these failures to crane twist and bad runway conditions and to the fact that straight tread track wheels provided no means of compensating for these defects.

The new bridge drive was installed July 2, 1929. It consisted of a single motor drive, the motor rating being 87 H.P. as against 130 H.P. for the old bridge drive. The four equalizing trucks with eight wheels were replaced by two end trucks and four taper tread wheels having a 5-inch tread. The end trucks were equipped with roller bearings with thrust washers to prevent end play or float. The wheels used were the new Carnegie rim toughened crane track wheels, the taper of the tread being made 1 inch in 16 on the radius or 1 inch in 8 on the diameter. These wheels have a maximum diameter of 27 inches and a minimum diameter of 26⅜ inches and are subjected to a maximum load of 50,000 pounds per wheel.

After more than six months of 24 hours a day service the writer inspected the new wheels with the chief engineer of one of the large steel mill crane manufacturers, and found the condition of the wheels to be almost perfect. This was far beyond our expectations. From present indications we should obtain many years of service from these wheels without any maintenance cost.

Bridge motor trouble has also been eliminated although less horsepower is now used.

My conclusions from the experience with this installation and the many similar ones in our plant are as follows:

First—Float or end play in journals is not only unnecessary, where extra wide taper tread track wheels are used, but is also undesirable. This is especially true of anti-friction bearings which are designed for rolling and not sliding.

Second—Heavy sustained end thrusts on the journals, which are obtained with straight tread track wheels, are not encountered when taper tread driving track wheels are employed.

Third—Longer life of track wheels and rails can be expected from this type of installation and as a result maintenance costs would be greatly reduced.

Fourth—A quiet smooth running bridge is another important result of the installation of taper tread track wheels. This factor makes for longer crane life and satisfied operators.

Fifth—It makes possible good crane operation on unsatisfactory crane runways.

Sixth—If the width of the tread of the follower track wheels is made narrower than the driving track wheels no wear will occur on the flanges of the driver track wheels. The maximum amount of weave is determined by the clearance between the rail head and flanges of the narrowest wheel.

Seventh—If the design of the driver track wheels will not permit of satisfactory provision for thrust, it is possible to take all the thrust on the follower track wheels by making their tread narrower than the tread of the driving track wheels. This construction was employed on our charging machine and as a result the flanges of the driving track wheels have never come in contact with the rail head. The flanges of the followers are brightened by rail contact, but not worn. The only evidence of wear on the drivers was a bright band 4 inches wide in the exact center of the tread. The remainder of the tread, ¾ inch on each side of this band, was dirty and showed conclusively that there had been no contact between that portion and the rail.

Crane Track Wheels and Crane Runways

By R. J. HARRY

Discussion

Discussed by

Frank W. Cramer, Chief Electrical Engineer, Republic Iron & Steel Co., Youngstown, Ohio.

Geo. W. Curtis, Timken Roller Bearing Co., Pittsburgh, Pa.

R. J. Harry, Assistant Electrical Superintendent, Carnegie Steel Co., Munhall, Pa.

G. W. Baumgarten, Assistant Electrical Engineer, Carnegie Steel Co., Duquesne, Pa.

Walter H. Burr, Superintendent, Electrical Department, Lukens Steel Co., Coatesville, Pa.

James A. Jackson, Plant Engineer, General Electric Co., Schenectady, N. Y.

Stanley Grand Girard, Electrical Engineer, Sharon Steel Hoop Co., Sharon, Pa.

R. A. Black, Chief Electrical Department, American Rolling Mills Co., Butler, Pa.

L. M. Wampler, Electrical Department, National Tube Co., McKeesport, Pa.

E. H. Aik, Electrical Engineer, A. O. Smith Co., Milwaukee, Wis.

John L. Lundberg, Engineer, Tool Steel Gear & Pinion Co., Cincinnati, Ohio.

F. W. Cramer: About fifteen months ago I happened to meet Bob Harry on the train one night. I had a problem on cranes on my mind at that time. We had a couple of cranes that insisted on running crossways on the runway. We had exhausted our ideas on how to correct this, so I asked Bob about it.

To prove he was an engineer, he pulled an envelop out of his pocket and started making sketches of this taper track tread wheel he has been showing you. I don't know whether he lost the envelop or not, but a few days later he sent me a print of the taper track tread wheel.

On this particular crane we had gone to the extreme of using tool steel wheels, and I think a record life was not much over two weeks. The flanges were all chewed to pieces. This idea looked so good that we immediately went to work and took a set of wheels that had the flanges chewed through on the hardened part and tapered them. That was Thanksgiving a year ago. Those wheels are running yet on that crane. That was our first installation.

We had another crane that was in similar trouble, only not nearly so bad. I think it was 110 foot span. It had no outrigger girder on to help keep it square and the chief trouble was that it was binding all the time. I thought that would be a pretty good place to try the taper tread wheel, so we again used another pair of worn-out tool steel wheels and put them on that crane. They are running yet.

The next place we tried it was on the stockyard crane with 100 foot span. I asked the foreman a couple of weeks later how it was running. He said "Fine." I thought I would go and look at it. We will take this for the driving end (indicating on blackboard.) He had the driving track wheels installed correctly, that is with the large diameter of the wheel on the inside. But when it came to the idlers, for some strange reason he had them on backwards. But the crane was running all right.

Mr. Harry brought out in his paper that you don't need to taper the idler wheels. We are tapering the idler because we want them alike.

Another thing is: Why do you want this second flange on there? You never get against it. I think there is a psychological reason for keeping that flange; it looks good anyway.

There was only one time we got licked on this job. I think Mr. Harry mentioned it. We had an inch clearance between the head of the rail and the flanges of the wheel. We put the new wheels on a crane and it didn't work well. When we checked up the runway I think the variation in span was something like an inch and a half or an inch and three-quarters. The wheels were doing all they could. When the crane used up all the clearance in the track wheels the crane bound on the runway. We couldn't straighten the runway so we put in wider tread wheels and that job is fixed.

From that time on I have been enthusiastic about the taper tread wheel and have told a good many about it and I know there are a lot of them in use over the country today. I at one time asked Mr. Harry why he didn't patent this thing and he informed me that was his gift to the crane industry.

I am very glad, both from the Association standpoint and his own, that he has presented this paper, for it will give Bob Harry the credit for bringing out a simple device that will get you out of trouble a lot of times and I imagine it will be only a few short years before everybody is using the tapered wheel on cranes.

In regard to the horse power, we had another funny experience. We had two cranes with tapered wheels on the runway and we bought a third crane with ordinary wheels and put it on the same runway. All cranes were specified for the same speed, and for anything we could see we thought they ought to run at the same speed, but the new one was always slow and in the road. We couldn't figure that out either. As soon as we put the tapered wheel on it, that one was up to speed too. It made a difference of thirty to forty per cent in the speed of that crane.

Another advantage is that the crane will start much easier and roll right off. The long cranes, when they stop, often bind on the runway and you

have to break them loose. The taper wheels will roll right off.

Another thing you will notice is that your wheels are polished and not chewed at all. It shows that you do have the rolling action right along and your rails are the same way. You also notice the sides of the head of your rails will get rusty and the inside flanges of the wheels prove that they never get against the head of the rail.

Another thing to watch out for is your variation in span.

There may be some questions that you would like to ask Mr. Harry. If so, now is the time to ask them.

George W. Curtis: In his remarks he mentioned the drivers having more clearance than the other wheels. I didn't quite understand the location of the drivers with reference to the idlers. I wonder if he could give us a diagram.

R. J. Harry: In the paper I stated that the driving track wheels had a 5" tread and the follower track wheels 4" tread. If you refer to figures 6, 7 and 8 you will note that the crane weaves as it travels along the runway. Owing to the tread of the followers being narrower than the drivers the flanges of the followers will make contact with the sides of the rail head when the flange of the drive wheel has ½" clearance. Consequently the worn portion of the tread of the driving wheel will be 4" wide, while the entire surface of the follower track wheel was worn.

As I brought out it may be necessary on some cranes to locate the track wheel gear on the outside of the truck. With this construction it is impossible to take the end thrust on the end of the track wheel pin, therefore if the tread of the driving track wheels are made wider than the tread of the follower track wheels the flanges of the driving track wheels will not come in contact with the head of the rail and consequently the driving track wheel pin will not be called upon to take any end thrust. With the above construction the follower track wheels will take all of the end thrust and this can be easily taken care of by installing thrust washers on the end of the pin.

G. W. Curtis: What do you consider the minimum width of tread on that wheel?

R. J. Harry: It really doesn't make any difference. As long as you have a taper there is a corrective action. In general it may be said where building clearances permit, the wider the tread, the better.

G. W. Baumgarten: What is the effect of increasing or decreasing the taper?

R. J. Harry: With straight tread track wheels there is no tendency whatever to square up the crane when it becomes twisted on the runway. With a slight taper there is a slight tendency to square up the crane when it becomes twisted and as this taper is increased so is the tendency to square up the crane increased.

G. W. Baumgarten: In other words if the taper is made twice as great it will only take half as long to assume its normal position.

W. H. Burr: Have you determined so far in your experiments, Mr. Harry, how much wear you can allow on the taper treads before it is necessary to turn them the second time?

Most men who have been connected with the Electrical Department in steel mills would be willing to sell their stock of experience for less than it has cost. I say this because there is in the plant of the Lukens Steel Company a crane runway actually built on a curve and we try to keep these wheels turned so that they are the proper diameter to follow this curve. Do you think under these conditions with tapered treads and wheels of proper diameter we would get satisfactory crane operation on this runway?

R. J. Harry: In answer to your first question would say that when wear on the flanges of the track wheels becomes pronounced it is time for these wheels to be taken out and remachined.

In regard to the crane traveling on a curved runway it would be the best practice to design these wheels with the proper diameters to suit the radius of curvature of the runway and also to taper the treads of these wheels so as to reduce the wear on the flanges. With this construction you would derive the same beneficial results on the curved runway as is obtained with tapered tread track wheels of equal diameter on straight runways.

James A. Jackson: As the crane travels down the runway with the weaving action as shown in Fig. 6, 7, 8 of the paper, there is a slight difference in the speed on the two ends, first one end being faster and then the other. When bridging a heavy load close to one end of the crane, for a long distance, have you noticed that there is any tendency to cause a pendulum swing to the load on the hook.

R. J. Harry: While it is true that as the crane travels down the runway and weaves, first one end and then the other will travel faster. There will be no tendency to cause a pendulum swing to the load on the hook, as in cranes of moderate span it will be necessary for the bridge to travel as much as a hundred feet before the hook moves one inch at right angles to the direction in which the crane is traveling. It is, therefore, evident that this action will not cause a pendulum swing.

Stanley Grand Girard: You said that with straight tread track wheels that when a crane became twisted on a runway that it would stay twisted and consequently you would obtain excessive wear on the flanges of the track wheel. I would like to know if you would obtain any wear on the flanges of the tapered tread track wheels.

R. J. Harry: Our experience on cranes equipped with straight tread track wheels has been that when a crane becomes twisted on a runway it stays twisted and consequently excessive wear on the flanges of the track wheel is obtained. Our experience with tapered tread track wheels is that practically no wear is obtained on the flanges of the track wheels. If you will refer to figures 6, 7 and 8 you will see that the cranes equipped with tapered track wheels make only intermittent contact with the rail head. This contact is only obtained when the crane becomes badly twisted. Under normal operation no wear is obtained on the flanges of the track wheel.

R. A. Black: Can you apply tapered tread track wheels on a double bridge drive?

R. J. Harry: The taper tread track wheels are equally effective on four wheel cranes, eight wheel cranes, or sixteen wheel cranes, single drive or double drive. Be sure that the large diameter of the

driving track wheels are on the inside of the crane and the small diameter on the outside as shown in Fig. 4.

L. M. Wampler: Where you have excessive wheel loads do you obtain rapid wear of the rail and the tread of the track wheel on account of the contact area being decreased where tapered tread track wheels are used.

R. J. Harry: Since the head of a rail is designed with a radius you will obtain just as much contact between the tread of the wheel and the head of the rail with a tapered tread track wheel as you do with a straight tread track wheel. The only difference that will be observed is that with a straight tread track wheel the wear on the head of the rail will be flat whereas with the tapered tread track wheel the head of the rail will wear on a bevel.

E. H. Aik: Do you feel that you will get as good results with the taper tread hardened wheel as you do with the taper tread rolled steel wheel?

R. J. Harry: I don't see that the physical structure has anything to do with it at all. We have rolled steel taper tread wheels on most of our applications.

The only difference between tool steel wheels, rolled steel wheels, or any hard or soft wheel, is that when you have a hard wheel you can expect long life. If you have a soft wheel you can expect short life. If the use of the crane is not severe, you may not be justified in putting on the hard wheel, which involves an added cost.

E. H. Aik: We have a very peculiar condition. Within the last year we purchased about twenty-five roller bearing cranes, practically standardized on roller bearings on all of our cranes. Up to this time we had no trouble at all with the treads of our wheels. We got quite a number of these cranes in and a few of them started to give us trouble with flange wear. That was on a very poor runway.

Recently we purchased two more cranes which were installed on an ideal runway. We started to have flange wear, and of course our men "raised Cain" about it. The only thing they could think of was that these cranes had roller bearings whereas the other cranes were bronze bushed. But when we got down to an analysis we couldn't show what it was.

Mr. Harry: The roller bearings are not the cause of the crane twisting which in turn brings about the excessive wear referred to.

E. H. Aik: We had just about begun to feel that we would have to go to steel wheels and take a chance on them wearing out the rails because our conditions were so bad. The point that has been brought out at this meeting has well paid for the time I have taken to come down here and I appreciate it very much.

R. J. Harry: I would recommend that you use the same wheels and taper them and I believe this will eliminate the troubles you are having.

John L. Lundberg: When the taper on the tread of the wheel is ½" in 8" of face of the wheel, what position has the contact tangent between the wheel tread and the curve top of the rail?

R. J. Harry: The contact will occur at a point where a line drawn at an angle of about seventeen degrees to the horizontal is tangent to the head of the rail.

J. L. Lundberg: Are you using the same taper ½" in 8" on the radius or 1" in 16" on the diameter on all of your crane applications even for example on a 150-ton crane where you use a one hundred pound rail?

R. J. Harry: Yes, even for applications on a 275-ton crane where a one hundred seventy-five pound rail was used.

E. H. Aik: Is the wear on the head of the rail more injurious with the tapered tread track wheel than it is with the straight tread track wheel?

R. J. Harry: We have found from actual experience that the wear of the head of the rail with the tapered tread track wheel is not as great as with the straight tread track wheel.

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*Electric Overhead Traveling Crane**

Questionnaire and Answers

Auspices

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS

85% of Steel Mill Tonnage represented in answers

Prepared by R. J. Harry, Chairman, Special Committee on Cranes

TO THE IRON AND STEEL INDUSTRY,
TO THE CRANE BUILDERS,
TO THE MEMBERSHIP OF THE A. I. & S. E. E.

The Association of Iron & Steel Electrical Engineers contemplate a revision of their Electric Overhead Traveling Crane Specifications and submitted a questionnaire to those interested with the view of obtaining expressions and opinions of present practice in the design, operation and maintenance of E. O. T. Cranes.

The following answers, which were received and tabulated, indicate the trend and the advances that have been made in the Crane Art.

Taking into consideration these answers, the special committee on Cranes will formulate the revision of the present E. O. T. Crane Specification and will present to the membership at Buffalo, June 17, 1930,

*Presented before the Pittsburgh District Section, A. I. & S. E. E., January 16th, 1930.

the tentative draft, for discussion. After this discussion, this special committee will prepare the final draft which will later be presented to the membership for adoption.

	Question	Classification of Answers	Mill Operating Supert'ds	Safety Department	Crane Builders
#1	Should crane girders be welded or riveted?	Riveted	43%	.....	56%
		Welded	34%	.....	16%
		Either	9%	.....	8%
		Both	14%	.....	20%

The answers to this question show conclusively that the mill operators are forcing the crane builders to employ welded construction to an increasing extent.
Many who favored riveting also stated that they liked welding but were waiting for the welded construction to prove its merit under actual operating conditions. Some recommend that both welding and riveting be used on cranes of large capacity and extremely heavy service.

#2	Should I beams with aux. girders be used for crane bridges where load and span permit?	Yes	69%	.....	84%
		No	29%	.....	12%
		Either	2%	.....	4%

A great majority of the mill operators and crane builders favor this type of construction. The use of I beams having very great section modulus permit this construction on cranes of large capacity and span.

#3	How should rails be fastened to the girders (welded or bolted)?	Welded	21%	.....	36%
		Bolted	73%	.....	52%
		Both welded and bolted	3%	.....	.....
		Either	3%	.....	12%

The operators favor the bolting of rails to the girder. This is no doubt due to the fact that this construction makes the changing of rails an easier task. Some favor the welding of the rail clips to the cover plate.

#4	What type of end truck do you prefer—cast, welded steel or structural steel riveted?	Cast Steel	56%	.....	24%
		Welded Steel	26%	.....	16%
		Riveted Structural Steel	8%	.....	20%
		Either Welded or Cast	7%	.....	28%
		Welded Steel (riveted and welded)	3%	.....	12%

While the sentiment among mill operators is for the cast steel end truck, the welded truck is coming more into favor.
The Crane Builders who supply the majority of steel mill cranes, favor the cast steel and welded steel truck.

#5	Does the use of heat treated track wheels justify the extra cost?	Yes	78%	.....	44%
		No	15%	.....	16%
		In some places	4%	.....	12%
		Depends on service	3%	.....	28%

Both mill operators and crane builders favor the use of extremely hard heat treated track wheels and consider the extra cost more than justified.

#6	Which do you prefer, heat treated gears and press fits or the untreated gears with shrink fits?	Heat treated gears—press fits	77%	.....	64%
		Untreated gears—shrink fits	13%	.....	12%
		Depends on application	6%	.....	12%
		Press fits in all cases	4%	.....	12%

In the past it has been the practice to use shrink fits almost exclusively. In order to use heat treated gears and track wheels shrink fits have been almost discontinued. It has been suggested that since many of the traction companies have discontinued the use of keys for track wheels that the same could be done on cranes. Most wheel failures are caused by the high stress concentration at the keyways.

#7	What type of track wheel bearings do you prefer, bronze, roller or ball?	Roller	72%	.....	56%
		Ball	1%	.....	.....
		Bronze	24%	.....	40%
		Depends on application	3%	.....	4%

From the above it is evident that the papers published by the Association of Iron and Steel Electrical Engineers on anti-friction bearings have been effective. This is more noticeable among mill operators than among the crane builders.

#8	Where brass bearings are used for bridge axles, do you prefer grease or oil lubrication?	Grease	57%	.....	16%
		Oil	43%	.....	76%
		Optional	.....	.....	8%

From the answers it is evident that the desire for cleanliness has driven many of the operators to use

grease. It seems to be the general opinion that oil is the better lubricant but owing to its undesirable features it is being superseded by grease. In many manufacturing plants the product is spoiled when lubricant falls on it from overhead travelling cranes, this has determined the character of the lubricant in many instances.

#9 Do you favor the use of bridge motors without axle bearings equipped with flexible couplings and gear reduction in oil tight gear boxes, or motors with standard back axle construction?

With back axle	62%	.....	68%
Without back axle	38%	.....	32%

In plants where it is the practice to use motors without back axles but with a flexible coupling and oil tight gear box, this construction has proven satisfactory from the standpoint of maintenance, cleanliness, and ease of motor replacement. We are of the opinion that in the future more cranes will use this construction.

#10 Many types of floors are being used in crane cabs. What type of floor do you recommend?

Steel Floor	5%	.....	8%
Asbestos Wood	33%	.....	44%
Wood { Board / Grating }	31%	.....	48%
Wood Block	16%	.....	.....
Concrete	10%	.....	.....
{ Concrete with rubber mat / Silocell Brick / Steel with rubber mat }	5%	.....	.....

It has been suggested that a double floor be used where crane cab is exposed to severe heat. While asbestos floors seem to be the most popular, the wood paving block has been found to be satisfactory where used, and easy on the feet.

#11 Do you find that crane operators object to the use of wire reinforced glass in crane cabs?

Yes	50%	17%	67%
No	50%	83%	33%

Instances have been reported where wire reinforced glass has been taken out and plain glass installed owing to the interference with crane operators vision. One reply suggested the use of shatter-proof glass. This suggestion has much merit as it gives the safety of wire reinforcing with none of the disadvantages.

#12 Do you favor installing magnetic control in a separate cab or locating it on the footwalk?

Separate cab	53%	.....	32%
Footwalk	32%	.....	44%
Depends on size of crane and whether inside or out	15%	.....	24%

While the majority still favor the installation of control in a separate cab, we note that a healthy minority favor the controls located on the footwalk. Many are of the opinion that the control is more accessible when located on the footwalk and as a result is easier to look after. When located on an outside runway a house for the control equipment can be built on the footwalk.

#13 Do you prefer single motor or two motor drive for bridge motion?

Single motor drive	52%	.....	65%
Two motor drive	48%	.....	35%

The general opinion seems to be that for short spans a single motor is satisfactory. There are a great number who favor two motors for heavy cranes or long span cranes. It has been found that cranes having a long span give satisfactory service when equipped with taper tread driving track wheels. We have a record of a 15-ton, 115-foot span, 8-wheel crane operating successfully with one bridge motor and two tapered tread driving track wheels.

#14 Should cranes be equipped with spring bumpers or solid bumpers?

Spring Bumpers	87%	.....	79%
Solid Bumpers	13%	.....	21%

The above tabulation speaks for itself.

#15 Do you install shunt brakes on bridges of cranes and charging machines, where the operator travels with the trolley, to prevent accident in case of failure of power while crane is in motion?

Use shunt brakes	67%	71%	87%
Use series brakes	8%	14%	13%
Do not use brakes	25%	15%	.....

The increasing use of anti-friction bearings makes the use of a shunt or series brake for this application imperative. Several recommend the use of a limit switch located at the end of the runway which automatically sets the brake when the crane reached the danger zone in case the bridge controller failed and the power supply did not. One man recommended the use of an automobile type air brake.

#16 Should platforms be installed under end of girders to facilitate changing track wheels?

Platforms under end of crane girders	78%	57%	58%

		Platforms attached to crane runway	10%	14%	21%
		Not necessary	12%	29%	21%

It is surprising to learn that anyone connected with safety work would answer this question negatively. It is unmistakably evident that the men, whose duty requires them to work on cranes, favor the use of permanent platforms attached to crane or runway girders.

#17	Do you specify that safe means should be provided to get on crane from crane runway?	Yes	96%	100%	84%
		No	4%	.....	16%

It is refreshing to observe that an item which was almost entirely overlooked in the past is almost unanimously adopted in present day crane specifications. This must be credited to safety.

#18	What warning signal do you find the most effective, Gong, Horn or Continuous bell alarm connected to line shaft?	Gong	68%	80%	83%
		Horn or Siren	14%	20%	.....
		Continuous bell	18%	.....	17%

The Gong seems to be the favorite crane warning signal. The continuous bell alarm finds its chief application on floor charging machines.

#19	Do you use sanders for bridge track wheels? If so, do you prefer electrically or manually operated type?	Yes—Electrically operated	61%	50%	87%
		Yes—Manually operated	9%	17%	.....
		No	30%	33%	13%

While an overwhelming majority favor the installation of sanders there are some who do not. One who objected to the use of sanders gave as his reason that it made the crane operators more reckless. He also stated that it caused excessive wear of wheels, rails and cover plates.

#20	Should main contact rails be located on columns above the crane or should they be attached to the runway girders under the crane?	Above	48%	60%	27%
		Below	52%	40%	73%

One disadvantage of locating the main collector rails on the runway girder, under the crane, is that when the trolley is racked to the extreme end of the crane there is danger of the hoisting ropes coming into contact with the collector rails and burning off. In most cases rails located on the building columns above the cranes are more accessible and easier to make repairs.

#21	Should trolley contact rails be located between the crane girders or on the crane footwalk?	Between Girders	13%	.....	10%
		On Footwalk	87%	100%	90%

One of the best safety accomplishments on crane was the moving of the contact rails from between the girders to the footwalk. This not only facilitated repairs but removed the hazard of hoisting ropes being burned off by swinging against the collector rails.

#22	Is it good practice to weld girders and gusset plates to end trucks on cranes already installed?	Yes	71%	.....	88%
		No	29%	.....	12%

These answers indicate the favor in which welding is held by both operator and crane builder.

#23	What type of trolley frame to you prefer, one-piece casting, one-piece welded frame, cast trucks with structural connections, or riveted structural frame?	One-piece Casting	53%	.....	44%
		One-piece Welded	23%	.....	12%
		Cast Trucks and Structural Connections	17%	.....	32%
		Riveted Structural Frame	7%	.....	12%

While the one-piece cast steel frame is the most popular at present, indications are that the welded trolley frame will eventually be most used. Castings are often made heavier than is necessary for the stresses involved in order to insure good foundry practice. Rolled members which enter into the construction of welded trolley frames are more apt to be sound than cast members.

#24	What type of bearings do you prefer, brass, roller or ball?	Roller	76%	.....	63%
		Ball	8%	.....	10%
		Brass	16%	.....	27%

The favorable experience in the field with anti-friction bearings is again evidenced by the above tabulation. There is still some aversion to the use of anti-friction bearings for track wheels journals.

#25 Where anti-friction bearings are used, how often are they lubricated?

The answers to this question vary from once every 10 hours to once every year. While the severity of service will to a great extent govern the frequency of lubrication, the majority of the answers indicate that once every four to eight weeks is sufficient.

#26	Where drums are keyed to drum shaft, do you use self-aligning bearings?	Yes	29%	.....	44%
		No	71%	.....	56%

In some types of crane construction, where drums are keyed to shaft, self-aligning bearings are absolutely necessary.

#27	Do you find that a reverse bend effects the life of the hoisting rope?	Yes	87%	80%	92%
		No	13%	20%	8%

The above answers indicate that the life of the hoisting rope is shortened by reverse bends. This item should be carefully considered in the design of new cranes and should never be employed where it can be avoided.

#28	Have you found the use of safety ropes on hot metal handling cranes justifiable?	Yes	39%	.....	15%
		No	61%	100%	85%

The majority seem to feel that safety ropes are not necessary. A good safety factor and frequent inspection is the best insurance against accidents from rope failures.

#29	Should equalizing sheaves have a diameter less than 30 times the diameter of the rope?	Not less than 30"	73%	.....	29%
		Less than 30"	27%	.....	71%

No doubt it is harder for the crane manufacturer to find space on the trolley for the larger sheave wheels having a diameter 30 times the diameter of the rope, but the operating men are unmistakedly in favor of the large wheel. Experience shows that many rope failures occur at the equalizing sheave where small diameter equalizing sheaves are used.

#30	Should crane limit switches be operated by the hoisting mechanism or should they be actuated by the hook block when it reaches a predetermined height?	By Hook Block	88%	100%	100%
		By Hoisting Mechanism	3%	.....	.....
		Either one	9%	.....	.....

The answers to this question leave no doubt in the mind of anyone as to the correct means of actuating the limit switch. There was one answer which read: "I never saw a limit switch that worked." Another said, "A discharge slip is the best limit switch."

#31	Should all crane limit switches provide dynamic braking and automatic reset for lowering?	Yes	93%	100%	76%
		No	7%	.....	24%

If this question had been split up into two parts, the first part reading "Should all crane limit switches provide dynamic braking" and the second part reading "Should all crane limit switches provide automatic reset," it is the opinion that there would have been a unanimous answer in the affirmative for the first question. In reading through the answers there still seem to be a goodly number who question the automatic reset feature. These men are of the opinion that the automatic reset feature makes the crane operators more careless, and results in the unnecessary tripping of the limit switch. It was stated that some crane operators depend on the limit switch for all high lifts. In general the answers indicated that the experience with limit switches having the automatic reset feature has been highly satisfactory.

#32	Have you experienced any trouble with limit switch failure where it was necessary to run the cable supporting the counterweight, over sheave wheels?	Yes	55%	50%	63%
		No	45%	50%	37%

There is no question but that the limit switch counterweight should hang directly from the limit switch. While it is necessary at times, owing to the restricted head room, to use sheave wheels between the counterweight and the limit switch, it should only be done when the direct method has been found impossible. Records are available of fatal accidents which have been caused by the counterweight cable fouling in the sheave supports and preventing the operation of the limit switch.

#33	What type of magnetic wire take-up reel are you specifying on your cranes—spring operated, torque motor operated, or gear or chain operated drums driven from the hoisting mechanism?	Gear or chain operated	59%	.....	76%
		Spring operated	33%	.....	24%
		Torque motor operated	8%	.....	.....

While the majority favor the geared or chain operated magnet wire take-up reel, there are a great many who favor the spring operated type. With the geared or chain operated type a certain amount of slack wire must be allowed to prevent breakage. In many cases this slack wire is very objectionable. The advantage of the spring operated reel lies in its ability to keep the wire taut at all times without breaking the wire.

#34	A great many trolleys are being built using worm drive on the hoist and trolley motion. Do you prefer this type, spur gear, or herringbone gear type?	Worm drive	46%	.....	58%
		Spur Gear	43%	.....	42%
		Herringbone	11%	.....	.....

It is remarkable that there are so many who favor the worm drive when it is considered that it has only been recently incorporated in the design of steel mill cranes. Some reasons for its popularity are the simplicity of design, accessibility, cleanliness, quietness of operation and high efficiency. One man in expressing his preference for worm drive stated that whereas spur gears wear out, worm gears wear in.

#35	On hot metal handling cranes it is customary to install a brake on the motor, another brake on the motor axle shaft and supplement both of these with dynamic braking. Are there any crane applications where the brake on the motor axle can be eliminated?	No	51%	20%	.....
		Yes	49%	80%	100%

The crane builders unanimously agree that on cranes, up to 25 tons capacity, having a motor brake and dynamic braking do not require a brake on the motor axle. They state that the introduction of the worm drive makes the motor axle brake even less essential. Many recently built cranes for handling hot metal have had the motor axle brake omitted with the customers consent. The dependability of the present day brake as compared with the brakes of a few years ago leads one to the conclusion that money should not be wasted on a motor axle brake where the crane is equipped with a good motor brake and dynamic braking.

#36	On the hoist and trolley do you prefer heat treated gears and press fits or untreated gears with shrink fits?	Heat trated and press fits	86%	.....	88%
		Untreated and shrink fits	14%	.....	12%

The above results show conclusively that heat treated gears and press fits meet the popular demand. There is no doubt but what the introduction of these refinements have had much to do with the lower maintenance cost of cranes.

#37	Do you prefer oil lubrication, grease cup lubrication or high pressure grease lubrication?	Oil	9%	.....	24%
		Grease Cup	15%	.....	.....
		High Pressure Grease	76%	.....	76%

There is no doubting the fact that the automobile has been responsible for some modern crane practices. High pressure greasing is certainly a product of the automobile school. The saving in lubricant and its efficiency should commend its use to those who do not now use it.

#38	Are you specifying oil tight gear cases or safety gear cases which afford chiefly a safety covering over the gears?	Oil Tight Cases	75%	86%	60%
		Safety Gear Cases	25%	14%	40%

The safety departments have forced the mill operators to equip their cranes with gear cases, and the results have been so satisfactory that the operators have gone the safety department one better by demanding that they be made oil tight. Oil tight gear cases have done more to increase the life of gears than any other device.

#39	Have welded gear cases proven satisfactory where used?	Yes	84%	.....	100%
		No	16%	.....	.....

The answers of the majority show that the welded steel gear case has given satisfactory results in operation.

#40	Do you prefer cast steel drums or cast iron drums?	Cast Steel	70%	.....	60%
		Cast Iron	30%	.....	40%

Cast steel drums are demanded by most steel mills, and there is no doubt that this opinion has been influenced by the uniformly better results obtained by the use of steel drums.

#41	Are mechanical brakes now obsolete for mill type cranes?	Yes	88%	100%	90%
		No	12%	.....	10%

For D.C. cranes where dynamic braking is easily obtained, the mechanical brake is happily placed among the relics of antiquity. For A.C. cranes it still finds some advocates. With the passing of the mechanical brake went one of the biggest items of crane maintenance.

#42	Do you find brakes to be necessary on trolleys equipped with anti-friction bearings?	Yes	55%	60%	64%
		No	45%	40%	36%

In many cases, where anti-friction bearing cranes were furnished without trolley brakes they were later installed. Most steel mills favor the use of trolley brakes for anti-friction bearing cranes, and feel that they are essential for safe operation. One answer read "Keep your girders level."

#43	Should sanders be installed on crane trolleys?	Yes	29%	20%	8%
		No	71%	80%	92%

The majority are of the opinion that sanders are unnecessary for crane trolleys. One man stated that sanders should not be used because the dry sand insulated the trolley from the girders and slight grounds on the hoist or trolley are conducted by means of the hoisting rope to the hook thereby shocking the men on the ground who hook on the load.

Probably the man should have removed the grounds and not the sanders.

#44	Should crane trolleys be equipped with spring bumpers?	Spring Bumpers	73%	.....	55%
		Solid Bumpers	27%	.....	45%

There is no doubting that spring bumpers are being used to an increasing extent, and that they save the crane from damaging impact.

#45	Do you prefer motors equipped with sleeve bearings, ball bearings, or roller bearings?	Roller	67%	.....	74%
		Sleeve	10%	.....	16%
		Ball	23%	.....	10%

The above answers seem to indicate that anti-friction bearings are superseding the sleeve type bearing. The sleeve bearing seems to be very quietly passing into oblivion to take its place with the mechanical brake. The reliability of roller bearings in automobile service has had much to do with the favorable attitude toward this type of bearing.

#46	Is it your practice to replace a defective motor or make the necessary repairs on the crane?	Replace	39%	.....	88%
		Make repairs on crane	19%	.....	.....
		Depends on trouble	42%	.....	12%

It is the general opinion that more satisfactory motor repairs can be made in the shop and that it is therefore, desirable wherever possible to replace the defective motor.

#47	What type of control do you prefer for cranes—magnetic exclusively, part magnetic and part manual or manual exclusively?	Magnetic	46%	.....	12%
		P. M. & P. M.	50%	.....	88%
		Manual	4%	.....	.....

Magnetic controllers are the choice of an overwhelming majority especially for the larger size of motors. For the smaller size trolley motors many prefer the manual control. There are only a few who prefer manual control exclusively.

#48	Should controllers have spring return handles to protect men and machinery in case craneman should be gassed, faint or otherwise incapacitated?	Yes	37%	60%	47%
		No	63%	40%	53%

In spite of the fact that the majority do not favor this safety device, it is being considered by many who have to face this hazard. (One man stated that spring return handles were unnecessary since he never had any accidents.)

#49	Do you prefer crane protective panels or should each control be equipped with its own protective apparatus?	Cont. Prot. Panels	27%	.....	33%
		Own Prot. App.	73%	.....	67%

The majority specify crane control equipped with its own protective apparatus. The majoritys opinion is that where magnetic control is used the protective features can be easily incorporated on the control panel which makes for simplicity. Where manual control is used it is necessary to install crane protective panels.

#50	Should cranes be equipped with a main line safety switch or enclosed circuit breaker?	Safety Switch	76%	57%	83%
		Circuit Breaker	24%	43%	17%

At the present writing the line safety switch is favored by the majority.

#51	Do you favor the exclusive use of unbreakable resistance for crane service?	Yes	90%	.....	50%
		No	10%	.....	50%

Practically all control manufacturers now furnish unbreakable resistance for crane control. The use of unbreakable resistance has eliminated another source of trouble, delay and maintenance expense.

#52	Should sleeve bearings on motor axles be grease lubricated or oil ring lubricated?	Grease	44%	.....	58%
		Oil	56%	.....	42%

Sentiment is about evenly divided. A slight majority of the mill operators favor the ring oiled bearing.

#53	Should motors be keyed to base plates?	Yes	65%	.....	92%
		No	35%	.....	8%

If this question was put to the motor inspector he would recommend that motors be keyed. This prevents any movement of the motor and loosening of foot bolts. In cases where it was necessary to tighten the foot bolts on bridge motors every week, this practice has been entirely eliminated by tack welding the motor feet to the base plate. It has been found that where the motor is prevented from moving the bolts do not loosen up.

#54 What formula do you use to determine the horsepower required for hoist, bridge and trolley motors when crane is equipped with sleeve bearings? Also formula when crane is equipped with anti-friction bearings?

There were very few answers to this question and these did not agree. It is recommended that the committee on crane specifications include in the revised specification, formulae for motor sizes on steel mill cranes.

#55	Should all bolts on cranes be equipped with cotter pins?	Yes	60%	83%	24%
		No	40%	17%	76%

Many plants have decided that cotter pins are as necessary for cranes, which travel overhead carrying loads over men and machinery, as they are for automobiles which travel on the ground. This is a safety measure which merits the consideration of all operating engineers.

#56 Do you install repair trolleys over crane runways to facilitate repairs with minimum labor and loss of time?	Yes	70%	67%	22%
	No	30%	33%	78%

The installation of repair trolleys should be considered on all new installations. It makes possible repairs with safety and the minimum loss of time, which would otherwise be hazardous and expensive. One stated he installed them when he could get them.

#57 What should be the minimum clearance between end of crane and building column?

The answers to this question varied from ½ inch to 36 inches. The majority favored 18 inches. Many men have been killed by being squeezed between the end of crane and building column. In the design of new building at least 18 inches clearance should be allowed wherever possible. One man stated that at least 12 inches clearance should be allowed "but try and get it." In the past sufficient consideration has not been given to this question.

#58 What should be the minimum clearance between highest point of crane and bottom of roof truss?

There is also considerable difference in opinion as to the proper clearance in this case. The general opinion was that at least 18 inches should be allowed between the highest point of crane and lowest point of roof truss.

#59 What kind of grease or oil do you find best suited for worm gears? For spur gears? For herringbone gears?

While quite a number of replies were received to this question, these replies indicated that there was by no means any standard practice, in the use of oil or grease, to worm, spur or herringbone gear drives.

It has been suggested that the Association of Iron & Steel Electrical Engineers could render the Iron & Steel Industry a valuable service, in promoting the formation of a Lubrication Engineering Division, whose duties and activities would be entirely devoted to Lubrication Problems.

#60 Has lubrication from a central location proven satisfactory where installed on cranes?	Yes	37%	.....	29%
	No	63%	.....	71%

Very few replies were received on this question, but the consensus of opinion was unfavorable to the use of centrally located lubricating systems. In the opinions of some, the system was satisfactory for cranes located inside, but unsatisfactory on outside cranes.

#61 Should crane operators be given a physical examination periodically? If so, how many times a year and how thoroughly should they be examined?

The answers to this question varied from no examination to examination every three months. About 55% considered once a year satisfactory. The majority thought that the examination should cover sight, hearing, heart and blood pressure.

A. I. & S. E. E.

Electric Overhead Traveling Crane

Questionnaire and Answers

Discussion

Discussed by

F. W. Cramer, Chief Electrical Engineer, Republic Iron & Steel Co., Youngstown, Ohio.

A. J. Standing, Electrical Superintendent, Saucon Plant, Bethlehem Steel Co., Bethlehem, Pa.

R. J. Harry, Assistant Electrical Superintendent, Carnegie Steel Co., Munhall, Pa.

R. L. Templin, Aluminum Co. of America, New Kensington, Pa.

M. B. Bradley, Harnischfeger Sales Corp., Cleveland, Ohio.

F. W. Cramer: We have to pass on to the next paper for this afternoon, after which we will all be given a chance to discuss and ask further questions. Mr. Harry has served as the Chairman of the Committee on Cranes. Some time ago he sent out a questionnaire with a long list of questions which we asked you to answer and send back to enable him to get the trend of opinion on cranes through-

out the country. For some reason which we can't explain, unless cranes is a subject we are all vitally interested in, he had a wonderful response to that questionnaire. I think we had about the largest response we have ever had to a questionnaire that has been sent out. Mr. Harry has tabulated the results which were obtained from that questionnaire.

We would like to now proceed to that part of the meeting and ask Mr. Harry to give his report.

Mr. Harry read his prepared report on the results of the questionnaire. The following remarks were made on a few of the questions as he made his report:

Question No. 7—What type of track wheel bearings do you prefer—bronze, roller or ball?"

A. J. Standing: Of that 68 per cent, how many indicated they had actually used roller bearings? Or is that merely given as an opinion?

R. J. Harry: I guess that is really an expression of opinion. It would have been a good thing to have asked if they had experience.

Mr. Kelly brings up a very good point—that slightly over 500 cranes, last year, were built for steel mills and more than half of those cranes were equipped with roller bearings.

A. J. Standing: That wouldn't be available in that answer.

R. J. Harry: Probably not all, although I think you will find almost every steel plant has at least one or more applications of roller bearings.

Question No. 12—Do you favor installing magnetic control in a separate cab or locating it on the footwalk?"

A. J. Standing: There again you have to take into consideration indoor and outside cranes in that answer.

R. J. Harry: In regard to that, where we have an outside crane we construct a shanty on the foot walk. Where we have an inside crane it is not necessary to do that. Personally I think it is much better to locate the control on the footwalk because it certainly is more accessible.

A. J. Standing: It is not necessarily located in the operator's cab.

R. J. Harry: No, I mean in a separate cab. So much of your space is used to get around the equipment that it takes a large cab to give you any room, whereas by increasing the width of your footwalk slightly you are able to take care of the control nicely. We have quit putting our control in the separate cab.

Question No. 18—What warning signal do you find the most effective—gong, horn or continuous bell or continuous bell alarm connected to line shaft?

A. J. Standing: You spoke of charging machines. Do the charging machines have a different type of signal than the overhead cranes?

R. J. Harry: Yes. That is the reason these fellows have a continuous alarm. As the charging machine goes down the runway the bell is ringing all the time.

A. J. Standing: You wouldn't want the cranes and charging machines to have the same type of sound.

R. J. Harry: That should have been incorporated in the questions.

A. J. Standing: We started out with gongs on both. Due to the similarity, we had to take the gongs out and put the horns on the chargers, leaving the gongs on the cranes, thus giving two distinct types of sound.

F. W. Cramer: I am sure we all enjoyed Mr. Harry's discussion. We have about twenty minutes left before we adjourn for the dinner party, and I would like to call on a few of the men who are left for some more opinions. I will call on Mr. Standing of the Bethlehem Steel Company to open the discussion.

A. J. Standing: Mr. Chairman and Mr. Harry: We have a few minutes left, so I will take each one of these fifty-four points in detail and discuss them at length.

First, I want to call your attention to the fact that the officers of the Association have had some misgiving at times as to just who is going to come forward and do the job we have tried to do. Our minds have certainly been set at rest this afternoon. Mr. Harry's very able performance for this afternoon has done that. There are no misgivings in my mind now that we have splendid material coming forth. I want to congratulate, not Mr. Harry, but the Association on the work which Mr. Harry has done and which is only a beginning of what he is going to have to do, whether he realizes it or not.

Touching for just a moment on the work of the afternoon, the first paper was extremely interesting and original. I think we all have something worth while to take home.

R. L. Templin: Your committee on rather short notice has requested me to tell you something about a new venture in the field of mill cranes. Some of you may have heard that we have built a crane out of aluminum, more specifically out of duralumin. This crane, while comparatively new, has actually been in service a number of months with apparently very satisfactory results, so satisfactory that we have decided to build more similar to it.

The first crane was a 10-ton capacity crane of 72 ft. 2 in. span and is located in a structural mill building while in another building adjacent is an exact duplicate made according to the usual steel practice. In developing the aluminum crane it was necessary to make but a few minor changes in the dimensions of the main girders. The depth of the girders was increased ¾ in.; the same thickness of web plates was used; slightly larger angles were used (3½ x 3½ x ½ in. instead of 3 x 3 x ⅜ in.); and the width of the cover plates was increased from 22 in. to 24 in.

Both this aluminum crane and the steel crane mentioned have been statically tested to about 72½ per cent overload and stress measurements made on the various parts such as the angles, cover plates and web plates using strain gauges. From these tests we found actually that there was less strain in the aluminum parts than in the steel parts. On the other hand the aluminum crane girders show more deflection than the steel girders under the same loads. The deflection in the case of the aluminum crane was about 2¼ times as much as in the case of the steel crane.

It is a little early perhaps to bring before you any reliable figures relative to the fabrication cost or the comparative economy of these two cranes. The operators who have been put on the aluminum crane like it very much because it gives them a very

snappy acting crane and one that handles beautifully.

It is very interesting to note that something over ten tons of dead weight was saved in the overall weight of the aluminum crane and we by no means went the limit in substituting aluminum for steel in the first installation. The main girders, the cab, the walk and the hand rail were all made of aluminum. A small crane now in use in one of our laboratories of three-tons capacity with a span of 23 ft. 6 in. is almost fully aluminumized as we say. It has duralumin built-up girders, duralumin grating on the walk, heat-treated cast aluminum trucks, wheels, hoisting block, drum and trolley, leaving only the gears, motors, drive shaft and cable of usual construction. The total weight of this crane is 8100 lb. We are at the present time installing another 10-ton crane of 81 ft. span and contemplating one of 50-tons capacity, 81 ft. span.

In fabricating these cranes we encountered the usual psychological troubles that are frequently met with in the introduction of new materials, but after the manufacturer had built the first crane and looked back at the situation, he could see no particular difficulties that could not be anticipated and taken care of in the fabrication of any future cranes of the same type.

In some cases hot steel rivets have been used and in others duralumin rivets. There is a slightly different technique required in the driving of duralumin rivets than in the case of hot steel rivets, but no serious difficulties are to be expected. We provided somewhat more cross-sectional area in the case of the aluminum alloy girders and specified self-aligning bearings on certain shafts in the crane in view of the greater deflection, but aside from minor things of this sort, there appears to be little difference in the design or fabrication of the aluminum crane.

Some of the obvious reasons for using an aluminum alloy crane is the saving of dead weight in the crane itself; the saving in the size of the crane rail girders and frequently in the size of the columns in the building where the crane is installed.

F. W. Cramer: Does anyone have any questions to ask Mr. Templin?

R. J. Harry: I was wondering if anybody had inquired about the aluminum crane, other than the Aluminum Company of America, in reference to the steel plants.

R. L. Templin: There have been inquiries from people who are not steel companies. I might mention the railroads among other people. We are always anxious to see a new venture of this kind tried out on the home ground before putting it into the outside commercial field. That, we believe, is the explanation for having installed these early ventures in our own mills.

M. B. Bradley: I might say that that subject was discussed at the time the Goodyear Zeppelin hangar at Akron was being built. They had cranes there that had to be very light in weight before the capacity would be handled and they had to go up in the air about 185 feet.

A. J. Standing: How would the reduced weight of these cranes affect traction?

R. L. Templin: We have experienced no difficulties in that respect. The friction between aluminum and steel is appreciably higher than that between cast iron and steel and when aluminum alloy wheels are used this works distinctly in our favor.

General Crane Discussion

Discussed by

G. W. Yanney, Chief Engineer, Alliance Machine Co., Alliance, Ohio.
Wray Dudley, Electrical Engineer, National Tube Co., Pittsburgh, Pa.
R. J. Wadd, Mechanical Engineer, Harnischfeger Corp., Milwaukee, Wis.
A. J. Acker, Sales Engineer, Manning, Maxwell & Moore, Inc., Pittsburgh, Pa.
E. S. Sawtelle, Vice President, Tool Steel Gear & Pinion Co., Cincinnati, Ohio.
F. S. McAmil, American Sheet & Tin Plate Co., Pittsburgh, Pa.
W. L. Poto, Alliance Machine Co., Alliance, Ohio.
James A. Jackson, Plant Engineer, General Electric Co., Schenectady, N. Y.
E. H. Aik, Electrical Engineer, A. O. Smith Corp., Milwaukee, Wis.
R. J. Harry, Assistant Electrical Superintendent, Carnegie Steel Co., Munhall, Pa.
R. M. Hussey, Electrical Superintendent, Jones & Laughlin Steel Corp., Aliquippa, Pa.
A. W. Mohrman, Electrical Superintendent, Follansbee Bros. Co., Follansbee, W. Va.
A. J. Standing, Electrical Superintendent, Saucon Plant, Bethlehem Steel Co., Bethlehem, Pa.
James Farrington, Electrical Superintendent, Wheeling Steel Corp., Wheeling, W. Va.
W. E. Miller, Electrical Superintendent, Bethlehem Steel Co., Johnstown, Pa.
R. A. Black, Assistant Electrical Superintendent, American Rolling Mills Co., Butler, Pa.
B. H. Kersting, Dravo Contracting Co., Pittsburgh, Pa.
W. B. McMasters, Electrical Engineer, Wheeling Mold & Foundry Co., Wheeling, W. Va.

G. W. Yanney, Alliance Machine Company, Alliance, Ohio: "I have been in the crane business in the capacity of Engineer for the last 27 years and have seen a great deal of changes made in the design of cranes. Twenty years ago electric overhead traveling cranes did not have the safety features with which present day cranes are equipped, which not only simplified the design, but made a much less expensive crane.

With reference to up-to-date cranes would say

that one of the outstanding features which we are stressing a great deal is the worm drive for hoist and trolley motions. In the design of this feature we use it in connection with a one-piece steel casting on standard trolleys. I note from the questionnaire that the majority of answers give the one-piece steel casting preference over any other design, also that the worm drive is receiving favorable recommendation from all classes of crane users.

Four years ago the percentage of our worm drive design to the total number of cranes built for the year was approximately 2%. For the year 1929 the percentage of worm drive installations to the total number of cranes built was approximately 30%.

Summing up the results of answers to the questionnaire would indicate that the ideal design for an Electric Overhead Crane would be worm drive for hoist and trolley travel motions, used in conjunction with a one-piece steel casting trolley frame. The bridge to be of the "H" section (where span and capacity permit), or box section main girder with an out-rigger girder to help carry the cab, bridge motor, footwalk, line shaft, etc. The two girders being built into one unit through the connecting members and footwalk. All bearings to be of the roller type with housings properly designed for oil seal."

Wray Dudley: It is hardly necessary for me to refer to this matter of improvement in design before this group of men. Many of you have seen the improvement more plainly than I.

A few years ago, I went down to Marcus Hook, N. J., to look over some second-hand cranes that were being offered due to the demolition of that plant of the International Nickel Company. Among the other cranes that I observed was one of the old-time ladle cranes with overhanging drums, cast iron wheels and cast iron brackets all the way through. It was a huge, massive thing that looked to be as full of danger as a stock of dynamite with the fuse ready to be touched off. It was not difficult for my imagination to visualize the danger which would exist as it rolled down the runway with a ladle of hot metal on the hook. Our modern ladle cranes are a far step in advance over that old design.

I feel that the Alliance Machine Company could have told us a great deal that is of interest regarding the development of the ladle crane.

R. J. Wadd: Do we have anything particularly interesting to offer in the way of design and development for cranes during the past few years?

Our development has mutually followed the industrial progress along conventional lines, adopting roller bearing features, welded construction where preferable, and the adoption of special steels and heat treated gearing of modern practice. There has been nothing particularly distinctive along these lines, except what you might conventionally expect in keeping with this day and age of development.

I do think that the most outstanding development has been along the lines of improved electrical apparatus, especially getting away from the old idea of manual control to the more modern type of magnetic equipment where you can begin to accomplish something in the way of economical maintenance.

I believe this is all I have to offer.

A. J. Acker: We didn't expect a roll call this evening and I thought we would remain modestly in the background.

There is one thing which we like to talk about when we get an opportunity and that is the Shaw spring end trucks as used on crane bridges. Most of you, I believe all of you, have probably seen a little model exhibited in the last three Association shows, so I do not need to describe it.

We hardly can call it a recent development because we have had cranes in operation for five or six years with these trucks on them. But in another sense it is recent, because we believe the need for it is developing from day to day. The reason I think that is a safe statement to make is because speeds are increasing. It is one thing to run a bridge at three hundred feet a minute and it is quite another thing when you step the speed up to 500, 600 or 700 or 750 feet a minute. These speeds are going to show certainly a great need for some cushioning between the wheels and the cranes. A crane is the only machine that runs on wheels without springs, and several things are going to develop the need for springs, and we are prepared when that time comes. It really is here because cranes are being built and have been built and are in operation up to 750 feet per minute on the bridge.

Another feature, it seems to me, that is going to call for the spring idea in end trucks, is the increasing use of magnetic switch control . The questionnaire this afternoon brought out the fact that a great majority are in favor of magnetic switch control, and those controls have a much longer life and lower maintenance, as has been found on those cranes which we have in operation, with the spring end trucks, because of the vibration is so greatly reduced that it is practically absent. Of course, lack of vibration helps all the parts in the crane, but it helps most and shows up first on the magnetic switch control. That need calls for springs on cranes and we are prepared to meet that need.

Thos. A. Bell: It is our pleasure to speak to the members of the Steel Trade, although we do not ordinarily class ourselves as builders of steel mill cranes, however, we appreciate the increased demand and field for standard overhead travelling cranes in and around steel mills, and in this connection, we believe we have something of interest to the steel mill engineer.

A few moments ago, it was drawn to our attention the seriousness of load deflection on crane trolleys, causing excessive wear of bearings and gearing. This is especially noticeable on trolleys where long shafts exist, such as on drum shafts and through axle shafts, as well as long motor extension shafts.

We have, we believe, eliminated this trouble in our new crane trolley design, in which we use a double girt construction. The top or cast steel girt, is used to rigidly tie the trolley sides in permanent alignment, and it is pin connected on four corners so that there is no possibility of the trolley becoming misaligned. This cast steel girt carries only the predetermined dead load weight of the hoisting motor and solenoid brake. A second structural steel load girt is used to carry the upper load sheaves and deliver the live load stress to the trolley sides directly over the center line of the truck wheels. This structural steel load girt is of the semi-floating type, and the pin connection allows the girt to adjust itself to the varying live load carried on the load block. The structural steel girt is, of course, free

to deflect and insomuch as the connection is directly over the center line of the truck wheels, there is no eccentric loading brought on the trolley sides.

Incidentally, the structural steel load girt acts as a safety device should for any reason, the solenoid brake on the hoist motor become out of adjustment and the load block be allowed to drift through the limit switch. The load block in striking the under side of the trolley, would strike first, the structural steel load girt and insomuch as it is not rigidly connected to the trolley sides, the weight of the girt would stop the block and although it may be slightly deformed, will not effect the alignment of the trolley in any way, as the alignment is entirely taken care of by the upper cast steel girt.

Wray Dudley: Do we have a representative from the Niles Crane Company?

Are there any other representatives of crane builders who have a word to say?

I may say, for you men who spoke a moment ago, that these steel mill men recognize that there is more than one class of duty for cranes and that they themselves would hardly be willing to pay the cost of a standardized steel mill crane unless the service required it. You gentlemen who are building cranes for the lighter service and who have aspirations to get into the steel mill service can certainly find out the essential requirements if you will give the members of the Association an opportunity to tell you just wherein improvements could be made. So don't overlook this opportunity.

I was not fortunate enough to hear the entire paper this afternoon on crane track wheels, but there is one class of track wheels that we might hear from at this time, and that is from the Tool Steel Gear and Pinion Company. Is someone from that concern present?

E. S. Sawtelle: I was extremely interested in the paper this afternoon bearing on the subject of taper tread crane wheels. We have a number of taper tread wheels out on test and are following them carefully to see if we can find the relative merits of this type of wheel and the standard tread design. As yet we have not been able to accumulate much tangible information, although the reports on the tests thus far are favorable.

Our company is particularly interested in a hardening process for crane wheels. I was pleased to see from the questionnaire reported that 75 to 90% of the replies indicated the hardened crane wheels and hardened gears were worth while.

The particular process that interests us is one where the wearing surface is hardened to about 90 on the Shore scleroscope to give extremely long life. Obviously if the taper tread wheel is desirable, it will be all the more desirable to have a wheel as hard as possible and as resistant as possible to wear, so that the taper in the tread may be maintained and the wheel will continue with taper tread action rather than wear in to a tread which matches up to the shape of the rail. This particular type of hardening process has been used for some twenty years and I believe that most of the replies to the questionnaire have been predicated upon the performance of this particular grade of hardened wheel. As you know, it is the same process that we have used on gears, on crane brake wheels, on pins for the trolley sheave wheels, the sheave wheels themselves, and various other crane parts.

In thinking over this subject of crane wheels, it seems to me that one of the problems that has not been given sufficient attention is the question of wheel loads. Recently we were inspecting a crane where the wheels had been wearing out prematurely, it seemed. In taking a rough calculation and comparing their load with that of a street car, we found that the load per wheel for a 24" wheel was just eight times as great as the amount usually put on the 24" wheel on a street car, and yet the street car people feel that wheels and wheel wear is a real problem with them! The duties are not directly comparable but they are similar. If anything, the crane probably has the worst of it.

Until recently cranes were practically all slow speed. Now they are being stepped up to over double the old speed which gives four times the momentum or blow if there is any gap in the rail or any obstruction, since momentum increases as the square of the speed. At the same time the weights carried, the frequency of the lift, and other factors have been greatly increased. Yet I believe that there has been a tendency on the part of crane operators and purchases to figure that certain standard wheels—we will say the 24" wheel—were used by Grandpa and ran his cranes so well that they are suitable for any crane today. With the increased loads and speeding up processes, even old cranes that may have given satisfaction with the standard wheel in the past may today be having wheel trouble more or less common or serious.

We have tried to gather statistics and see if any authentic tables were available giving wheel loads under various conditions. I do not know of anything that has as yet been released on that subject. Frankly I think everyone is afraid to release it. Mr. Kelly suggested that this subject would be extremely interesting to the Association and we prepared a table of permissible loads for low speed and high speed operation. I believe that this is to be printed in your publication and I will not attempt to read the whole table here; it would be too cumbersome. We must, however, point out qualifying features which influence crane wheel loads.

(a) The overall load on the wheel.
(b) Whether the runway is kept straight and parallel.
(c) Whether the rails are kept smooth and the joints closely welded or butted.
(d) Whether the building construction is affected by heat or cold to cause misalignment.
(e) Cranes for soaking pit service where the load is usually carried on one side.
(f) Cranes operated outdoors and subject to weather and wind load.
(g) Bridge speed.

You probably know of many more conditions and realize it is hard to make any formula that will be a fair composite. The table we have prepared shows normal permissible wheel loads at speeds around 300 feet and at speeds around 600 or 700 feet. We are willing to submit this table for printing if you desire it, purely as a starting point for discussion. We recommend that this subject be followed further in your investigations and discussions to see if something cannot be developed to guide the builder and

the man preparing specifications and to see that the right sized wheels and rails are under cranes.

I might mention another test which we recently conducted in an effort to see the difference between relative sizes of wheels and relative hardness of wheels. We started with two wheels of the same diameter, one a high carbon untreated, and the other hardened by the Tool Steel process. These were put on an 85-pound rail and subjected under a hydraulic press to various pressures. Accurate measurements were then taken as to the amount of decrease in the distance from the center of the wheel to the bottom of the rail when the pressure was on, indicating the amount that wheel sinks in to the rail. Theoretically it is a point or line contact but practically the wheel imbeds itself into the rail to an amount depending on the pressure and this is the factor that gives good traction. We found that the hardened wheel under heavy pressure left a shallower permanent impression in the rail than did the softer wheel which would indicate less tendency to roll out the rail. This was probably due to the fact that there is a little more resiliency and spring in the hardened material with a softer backing than in the homogeneous high carbon steel.

Then, taking the various sizes of wheels on the same rail and subjecting them to equal pressure, we found that the permanent imprint in the rail decidedly decreased in depth as the diameter of the wheel increased. We believe that this indicates that the rolling or peening action on rails, often evidenced by a spreading or flowing of the rail, can be corrected sometimes by a change in the quality of material in the wheel, sometimes by increasing the diameter of the wheel, sometimes by using a heavier rail, or by any combination of these factors.

In existing cranes it is usually difficult to increase the diameter of the wheel or the size of the rail due to lack of room. You will probably need to get along as best you can and use the highest quality material to rectify troubles. I believe, however, that there is too little reliable information available on the subject of wheel loads and it would be an exceedingly good thing for the industry if you gentlemen through your committees could study this subject and see if you cannot agree on some table that will eliminate what is more or less guess work at present as to the size of the wheel and rail. Such information would be extremely valuable in connection with specifications for new cranes that might be purchased.

Wray Dudley: I think crane wheels have imposed certain evils which we have endured for years instead of attempting to find some way of curing them. Those of you who have never looked into the subject of wheel loads in your heavier loaded cranes in comparison with the wheel loads under steam locomotives of heavy tonnage will be surprised to learn to what high pressures the crane builder usually is compelled to go. If this is done you will more clearly and easily understand why rails break down, and wheels wear out unless properly proportioned to the work.

Aside from the excellent qualities which doubtless many of you have found in Tool Steel Gear and Pinion Company wheels—this is not a free advertisement for them—I think this firm is to be congratulated for their courage and optimism in attempting to sell to steel mill people a product which went under the name of "Tool Steel." Many of you will readily recall in the early days, when you were first attempting to try out this wheel, what difficulty you had in persuading your general superintendent or manager, or whoever O K'd the requisitions, to approve one for a "Tool Steel" wheel. It took them some time to learn that it was a tool steel process rather than a tool steel wheel.

Is there anyone else present who can give us some point of interest and instruction on cranes?

You know, this subject of cranes is a prosaic thing and yet there is no other one piece of machinery in a mill that is more important than a crane. While their design, construction, maintenance and operation have been advanced tremendously since the Association first undertook to produce a standard specification, there is still, we must admit, room for improvement. It will probably come in detailed parts, such as wheels, bearings, spring support, cables, drum equalization, girder construction, etc. This subject has not been exhausted by any means.

The new crane specifications which the Association will soon have issued and place in your hands will not be the last word. It will be an approach towards the ultimate crane, but as conditions in the industry change, necessarily that machine which supplies its needs twenty-four hours a day must likewise change with it. We have not seen the end of the crane development by any means.

Would any of the users of the cranes care to propound any questions to the crane builders or present to them any thoughts of their own.

Gentlemen, if there is nothing more and no one else has anything to say I may say the discussions and papers we had today will appear in an early issue of the Association Journal, the Iron and Steel Engineer, and you will be able to obtain in greater detail than perhaps your minds will carry with you tonight the items of interest that have been brought out.

F. S. McAmil: I would like to ask the crane builders if there is a keen interest in the pre-formed cable for hoisting purposes and if they have anything to recommend for or against this construction. I would also like to get the viewpoint of the users.

Wray Dudley: Just imagine what happens when a new cable is hung over a sheave and it is stressed to its working load. Every strand in that cable must necessarily assume its portion of the loading and is forced to take up a position different from the one it occupies when without load. Many times those individual strands are not true to assume their proper position and that is the time when things happen to a cable that are hard to explain. But if you could see what is occurring in each one of those strands it might not be so difficult to understand. Has anyone anything to say on that point? I think that is a very vital point and we are willing to consider anything that will be an improvement and will make for safer operating conditions.

W. L. Poto: The Donner Steel Company of Buffalo has used this cable exclusively, and they get very excellent results. That is about all I can say about it.

James A. Jackson: I haven't had any actual experience with cable, but I attended a meeting in

New York, held under the auspices of the A. S. M. E., a short time ago, where they are trying to organize a research committee on wire rope. One of the points which was discussed was how to determine when to take a rope out of service.

We had with us that day Mr. Sperry of gyroscope fame. No doubt many of the steel mill people are familiar with the work that he has done in building a graphic recording machine to determine where flaws exist in a railroad track. He was very much interested in this wire rope question, and at the second meeting of the wire rope research committee, he said he had made tests on wire rope with a similar type of equipment used for determining the flaws in a steel rail and was ready to guarantee that it would determine breaks in the individual wires of wire cables to the same extent it does in the steel rail. He felt sure that a machine could be devised which could be very readily adapated to either crane, mine hoist or elevator cables, so they would not have to be taken off but could be completely inspected on the job and determine where every broken wire existed. I thought it would be of general interest to know that Mr. Sperry is interested in this subject.

Wray Dudley: It is interesting to know that someone can find a way to note a cable before the fault makes its appearance.

E. H. Aik: There is one matter that hasn't been discussed. I don't know whether it has been brought up in meetings before, but it is something which has a good deal to do with the performance of the crane. That is the matter of the crane runway.

I would like to know what the experience of these men has been in regard to the use of rail clips or hook bolts—whether they found any advantage one way or the other. Should rail clips be fastened in such a way that they allow the rail some movement, or should they be fastened very solidly in the runway. I think it may have something to do with the performance of the crane, and I would be interested in the experience of other men.

Wray Dudley: Mr. Harry, can you give this gentleman some information on that subject?

R. J. Harry: The crane I spoke of was equipped with hook bolts and almost every day we carried two or three dozen bolts to replace those broken off. I can assure you that since we have used the taper tread wheels that trouble has entirely ceased.

Wray Dudley: There is your answer. Anyone who has tried to keep the hook bolts tied up knows that if the taper tread wheel will take care of that there is one big trouble of maintenance out of the picture.

R. M. Hussey: I would rather not say what I think about that.

Wray Dudley: All right. You had something to tell us.

R. M. Hussey: I have a question or two. I understood Bob Harry to say that in the answers to question No. 31, "Should all crane limit switches provide dynamic braking and automatic reset for lowering?" there were 89 per cent who said "Yes." I would like to have seen that question broken up into two separate questions, the second one being, "Should the crane limit switch provide for automatic reset for lowering?" I think maybe there would have been a little difference of opinion on that part of it.

I want to put that as a question: Should the crane limit switches be provided for automatic reset for lowering? The reason I ask that is because of some very unpleasant experiences lately, which have led me to believe that probably the crane limit switch should not be provided for automatic resetting and lowering. I think with the crane limit switches rigged up they are, particularly on those cranes where you have to take the load nearly to the top every time because of high piles or because of low runways or some other reason, the crane man will be prone to use it as a utility—let the load go up without watching it, depending on the limit switch to stop it every time. I believe we would all agree that that is not the right way to use the crane limit switch. I believe that the crane limit switch, fixed so that the crane man or motor inspector would have to be called and sent on top to reset it every time the load does go up and is stopped by the limit switch, would force the crane man to be more careful of his hoist operation and probably save a bad accident, because, with all due respect to the people who design crane limit switches and the people who make them, I never yet have seen a device that will not fail at some time.

I would like to hear something from the others on that question.

A. W. Mohrman: Mr. Hussey asked for expression on the idea of having limit switches "fixed" so that crane man must call for help to reset. If Mr. Hussey has ever run a crane he can readily imagine what a crane man is up against when he must go up or even through limit stop in order to do his work, a crane man does not willfully go through a limit stop. In some study on limit switches I have found that he is as a rule forced to do so and usually at a time when if he was to call a motor inspector to reset the limit, there would be a lot of loose hair lying around. In a year of study I have found that limits were operated on a particular crane 481 times and of these it was found that 9 times were so-called accidentals either by neglect of crane man or from improper operation of control.

There are on the market today several limit switches most of them have the same evil of opening the armature circuit, and at this point the enherent characteristic of the machine will allow the hook to go through, if the crane man has his controller shut off or almost shut off at the instant the flop over is made. I know that a limit stop can be made which can be used as a stop each time the crane is hoisting and it will stop at set point every time and I know that it only requires ¼" of travel for operation, also it will stop the hoist when overtravelling in the reverse direction, this point cannot be protected by those now on the market, unless the crane man is provided with an alarm clock which will wake him up when the hook gets to high. I also believe that the proper education and a little encouragement to the crane man will eliminate all the grief of the limit switches.

Wray Dudley: In other words, Mr. Hussey wants to bring some element of supervisory control, the human control, into the circumstance which occurs when a crane overruns; and the gentleman from

Ogden, Utah, Mr. Mohrman, visualizes the disturbance that will be raised when the crane sits there and everybody on the floor is raising all the rumpus they can while the crane man climbs down the ladder and hunts the motor inspector and asks him to get up on the crane and reset that limit switch. There is something to be said both ways.

Mr. Standing, could you let us have a word on that?

A. J. Standing: Yes, I have had some experience. We have one peculiar shipping yard which has 40 ten-ton, double trolley cranes each equipped with two five-ton trolleys. They pile steel in each runway, there are fourteen crane runways in the yard. The yard covers twenty-eight acres and every man is on a tonnage basis. Picture that proposition; if they had to get an electrician with nine men on day turn and six on night turn to cover twenty-eight acres with hand set limit switches, we would be shut down so quickly we wouldn't know what happened.

Since the limit switches have been put on, I have been able to cut my maintenance force down in that yard and the operating efficiency of those cranes has increased in a like manner. So I don't think there is even a shadow of doubt as to the reset of limit switches.

Wray Dudley: Would you tell us what have been the objections, if any, that have come out of this experience there?

A. J. Standing: There have been none. I had one case of failure where a limit switch stayed on center. That case resulted in a fatality, I am sorry to say. The crane man, a man of about eight years experience, left his controller in the running position and went up on top his crane and knocked the limit switch over, and the motion immediately started, and he was thrown on the ground with a carload of beams and killed. That is the only accident we have had, and the limit switches have been in there for possibly five or six years. We have had very satisfactory results.

So much for the limit switches. There are two or three other points that came to my mind. First, in steel mill service we talk a lot about heavy-duty steel mill cranes. But some speaker mentioned the fact that we all must realize that we have in our plants a great many points where a so-called commercial industrial crane will do our jobs and do them very satisfactorily and do them very cheaply. And I think we who have the buying power of cranes are missing a big bet if we tie ourselves up with some heavy-duty crane perhaps that is all right for heavy-duty steel mill work and put it in the yard or power station where it is not needed. We are spending too much money.

These so-called light-duty cranes in this class of service have a very good maintenance record. Their record for service corresponds very accurately with the maintenance records of heavier duty cranes in heavier service. So why are not the lighter cranes justifiable in a great many places in the service in steel mills?

Second, mention has been made of the speeds increasing. I know they are increasing, but I am not prepared to say that they are increasing justifiably. I think there is an epidemic of demand for high-speed, overlooking the fact that the interval of travel of the crane is small compared to your twenty-four-hour operations of any given job. So why jeopardize a fast-moving crane in order to run 600 feet a minute when you could accomplish the same job at 250 or 300 feet a minute and make up that time in your process, because as you run at high speeds with heavy cranes, you have to absorb more energy in handling the crane and the crane has to take more punishment. As Mr. Sawtelle pointed out, the track wheels have considerably harder abuse, and while there are places and operations where that may be justified, I think the tendency is to run too fast on operations which are not justifiable.

There is one point Mr. Sawtelle made to which I want to take exception right now, and that is the fact that if the crane builders start to design the proper wheel for every individual crane, we will meet just the condition we licked about seven years ago. We found some twenty-two odd sizes of wheels, which were in vogue among the different crane builders, and the Crane Standards Committee, of which I was a member at that time, reduced that I think to some seven or eight different sizes and stipulated some predominating standard sizes which have now become standard with the wheel makers. While there may be some of those sizes that are on the upper limit and lower limit of the class, nevertheless I think your losses due to wheel failure are not as great as would be your costs involved if you went back to the whole ramifications of sizes that everybody felt was applicable to their particular crane.

R. M. Hussey: That wasn't the answer I wanted. I haven't got the answer yet. It is one thing to get bawled out for having a crane down and have to get men up to keep it going and get involved in arguments. That is one kind of pain. The other kind of pain is to be involved in a fatal accident. And that is just the experience we have been through, not so many weeks ago.

There is an attitude developing among our people that it is very much in line with safety first, that if a condition is not safe you should shut the machine down and make it safe. I believe there are many who will agree with me that if you adopted a policy of using a crane limit switch that did not automatically reset you wouldn't tolerate operations where you had to send men up on top, very long before you would fix it so you wouldn't need to do that.

If this thing had been discussed several months ago, I would have been of the same opinion as the two gentlemen who just spoke, but right now I am in another position.

A. J. Acker: It is not impossible to put on two limit switches and have one set to trip a little below the other. In that case the lower one would be arranged to reset automatically. If, then, the lower one fails, the upper one will be tripped and it should be so arranged that it must be reset by hand, in which case the crane operator must either call the motor inspector or climb up on the crane and reset it himself. In either case, he then has warning that his every-day working stop is out of commission and should be fixed.

In other words, where the limit switch tends to be tripped on every lift, there should be both a

service stop and a safety stop. The service stop should, of course, be set to function a little lower than the safety stop. We all know that as soon as a safety device is called upon to function at every operation, it really ceases to be a safety device.

James Farrington: I am going to side with Mr. Hussey. When I put that thing through, we had a case where in changing rolls you had to hold the limit switch in. We came near having an accident, so I made it such that when we went out we would have to call the motor inspector and the foreman.

We had trouble the first two or three times, because, of course, we held the mill up. So we told the superintendent that was the best we could do, but if he wanted to take the responsibility of a fatal accident I would let him sign a paper to that effect and take it to the general manager and cut it out. But the superintendent wouldn't take the responsibility and in about a week or ten days they made a different lifting equipment so now the limit switch is working and they do the work without tripping the limit switch each time.

I wasn't here at the meeting today, but I would like to ask if any of the members have considered welding their runway rails solid so as to do away with all joints.

Wray Dudley: Mr. Harry, what can you tell about welding runway rails so as to do away with all joints?

R. J. Harry: I can't tell very much about rail welding, but I believe Mr. Miller from Johnstown, who is here, has had some experience with it and can give us some information along that line. I know we had a committee go up there to make an investigation and they were very favorably impressed with the rails welded to the runway cover plate.

Wray Dudley: You mean welded to the runway?

James Farrington: I mean the joints welded, doing away with fishplates.

Wray Dudley: What we want is information. Mr. Farrington asked for information on the welding of the joint in the runway rail, doing away with fishplates. We were told that you had some experience on that, Mr. Miller.

W. E. Miller: We don't do away with the splice bar or fish plate, if you want to call it splice bar or fishplate. We weld the rail to the runway cover plate welding beads about 4" long along the rail about two feet apart staggering them on the opposite sides of rail.

Wray Dudley: You retain the splice bar?

W. E. Miller: To keep the ends of the rails closely in line. We believe this to be a better job since it prevents the rails springing apart.

Wray Dudley: How long have you had this in?

W. E. Miller: We have been following this practice for at least three years. Some of the welds on some of the older runways have failed. I don't know that that was due to alignment. I think it was just a matter of the human element in welding. The welds were not properly made and failed.

Wray Dudley: Does that answer your question, Mr. Farrington?

James Farrington: Did this do away with the wearing of the rail at the end?

W. E. Miller: Yes, that is one reason we adopted the welding of the rails to the runway cover plate—because under the old way of clamping rails to the cover plates it was almost impossible to keep the rails from pulling apart. That is, the wheels would slide the rails under the old rail clamps until the rails became as far apart as the slotted hole in the fishplates would permit. The crane wheels in passing over these openings then gradually pounding down the rail ends making a bumping runway. Where the rails were not hammered down at the ends we moved them up and put them up close and then weld them fast to keep them from creeping, which eliminated the bad wear on the end of the rail. Of course, after your rails are worn and you get the hollow spots, the rail is ruined and you have a condition which cannot be corrected by welding. You then must start with new rails, when you get a perfectly smooth runway for your crane to travel on. In fact, in traveling over such a runway on the crane you would imagine it was all one rail.

James Farrington: How do you compensate for change in the line of the runway girders? In building changes we find our runway not always in line at the end of the year. It would take the rail with it.

W. E. Miller: The rail travels with your girder. We haven't developed any trouble of that kind.

There is another practice that they are using in the steel plants, for instance John Reed at the Steelton plant who is using fishplates but is bolting them with body bound bolts in both the rails and the fishplates. This holds the rail ends securely together. He then welds the rail clamps to the girder cover plate leaving the rail free to move through the clamps. But I think the rail weld to the cover plate is a better arrangement than that because it does away with all creeping of the rails.

When we built the new Gautier Mills we got into trouble with the crane runways, the heavy cranes pulling the joints apart, giving us bumpy runways. After you get a bumpy runway the clamp bolts loosen up and permits the rails to get out of gauge. We corrected this trouble by welding the rails. We have done this on our new Soaking Pit Crane runway that has been in operation about two years. We checked the gauge and welded the rails with the mill in operation and after it was corrected I haven't heard of any trouble.

R. J. Harry: When Mr. Miller is welding the rails to the cover plates, I would like to ask whether he has the crane directly over the portion he is welding in order to be sure the rail is making contact with the runway cover plate.

W. E. Miller: We do not. We get the cranes at the end of the runway; loosen the rest of the rails, set them to gauge and clamp them to the runway temporarily to hold them while they are being welded. We can sometimes use the old rail clamp holes for this purpose, but not always. Almost any method of clamping the rails can be used that will hold the rails in position until they are welded when the clamps are removed.

Wray Dudley: Is there anyone else who has anything to add.

R. A. Black: Mr. Chairman, there are a lot of questions being discussed this evening that have been worrying me for a long time. When the questionnaire came out and they talked about welding the rails to the girder, I had in mind that it was

the crane runway rails along the building. Did you mean that, or were you talking about the rails across the crane girder?

R. J. Harry: I meant the welding of the rails to the cover plate of the crane girder.

R. A. Black: We have had a lot of trouble with our rails getting out of line on main runways and we don't know how to hold them. We have adopted the hook bolt system. You fellows don't seem to like that, because you carry them out by the bucket full. We haven't had that trouble. Some girders are very crooked. If we attempted to weld the rails to them we would get into trouble; so we are using hook bolts quite successfuly.

The other question I had in mind was the welding of the rail on the counter plate. Will the expansion of the rail not give a lot of trouble? If you are welding them and butting them close together, isn't there considerable misalignment from expansion?

R. J. Harry: I think you will find the same expansion in the cover plates as in the rail.

R. A. Black: In discussing the butting of the rails, I find quite a number of men who are of the opinion that there should be a hard wood wedge between the rails to allow for expansion. Whether it is good practice or not I don't know. But if you gentlemen are butting the rails together, we can too, because we have the same general conditions and won't have any more expansion than you have.

Wray Dudley: In regard to driving the wooden wedge into the rail, I want to call your attention to the fact that up until a year or so ago there was a gentlemen in northern Illinois who believed the world was still flat. So driving wooden wedges in is not at all unusual.

W. E. Miller: It is an easy matter under this scheme to get the runway rails set to gauge on a runway where the alignment is poor. The rails can be set any where on the girder. In some bad cases we were forced to replace the rivets of the girder with countersunk rivets so that the rails could be moved closer to the edge of the girder. In cases like this it would have been necessary to install new girders where clamps are to be used on the rails instead of welds.

A. Mohrman: There is one more question. How does Mr. Miller take his own off? What does he have? I wonder what kind of a job he has in taking the old rails off and putting new ones on. Did you ever change any?

W. E. Miller: Yes there are sometimes occasions when the rails are welded a little out of line. In such cases the rails must be rewelded at the places where misalignment has occurred. To remove the welds we start a wedge under the rail and then burn off the weld with an acetylene torch. The rail is then clamped to the correct line and rewelded.

There is another thing to be careful of. That is that all the grease must be taken off the girder where the welds are to be made. Grease will cause hard spots and cause faulty welds. We have found the acetylene torch useful in burning off the grease.

Wray Dudley: If you could take all the grease off the old girder you could do almost anything with it.

I would like to ask Mr. Miller: Do you use electric welding on these rails?

W. E. Miller: Yes.

Wray Dudley: You just use the gas to cut it off?

W. E. Miller: Yes, we use gas only to burn off the old welds and to burn off the grease where the electric weld is to be made.

Wray Dudley: That is absolutely correct. The electric welding is the thing to use.

W. E. Miller: But you have to have a machine that has at least 300 ampere capacity if you expect to get proper penetration.

Wray Dudley: You don't have any difficulty from the high carbon steel in the rail?

W. E. Miller: No. The secret of this is to heat up the rail well and puddle the weld thereby reducing some of the high carbon content of the rail at the weld.

Wray Dudley: What kind of electrodes do you use?

W. E. Miller: 13 to 18 Carbon bare 3/16" diameter.

Wray Dudley: You are probably using a low carbon electro, a standard electro.

A. J. Acker: Mr. Hussey didn't seem to think very much of my bright suggestion. I don't know why. I suggested two different kinds of limit switches, maybe a guy to the hoist type for your every-day use for stopping in spite of the operator, and a hook type for safety, set just a trifle above the other, and have this second one so that it must be reset by hand. That gives everybody warning that the first limit switch is out of commission.

Wray Dudley: Mr. Hussey, do you care to comment on that?

R. M. Hussey: There is nothing more at this time that I can say except that I appreciate that information. We will give it thought and attention, because we are not satisfied with what we have. We have lately had some rather sad experiences and are open minded to any and everything that will make for safer operation of cranes.

Wray Dudley: That question is very important and the solution of it would carry with it the solution of many other problems that enter into crane operation; that is—human control versus mechanical control. There is much to be said on both sides.

I believe that Mr. Hussey, in common with every other steel mill electrical superintendent, would prefer to keep every device off his crane that was not necessary to its safe operation. The simpler the better, and adding another limit switch is just one more device requiring attention and maintenance. In common with many other superintendents we would prefer to find some other means of preventing overtravel of the hook.

Mr. Farrington's experience was very illuminating. As soon as the men on the floor were in trouble, and the responsibility for damage due to overrun was put up to them, and they had to say whether the risk should be run or not, they refused to take the responsibility and found another way to avoid the difficulty.

I am sure all of you have experienced this. The ingenuity of the electrical superintendents has been taxed to the limit to find ways of overcoming difficulties largely arising from operating conditions over which they have no control. I have long felt that the time would come when, instead of turning to

the electrical department for the connection of many departmental abuses the departmental heads affected would likewise be called upon to exercise their ingenuity and resourcefulness and enterprise to overcome the difficulties which lay in their own hands. When considering a subject of that sort, we are covering the most important points which affect the operation of a steel mill and that is the human element. We have made long steps forward in overcoming old time conditions which hampered the electrical department, but there is still much to be done.

The experience which Mr. Standing describes in his shipping yard with the installation of the extra limit switch is very valuable and certainly gives convincing arguments for the use of the mechanical device. Twenty-eight acres of cranes and a substantial reduction in delay, maintenance and men—There is much to be said on the mechanical end of it.

B. H. Kersting: I had occasion to inspect an installation of dock cranes not so long ago and noticed they were still using copper trolley wires for conductors. I would like to ask whether it is still good practice to use trolley wires for conductors. We still use them.

Wray Dudley: When you mention the use of trolley wires on cranes, it is only the charity of these steel mill superintendents here which prevents you from being thrown out of the window. However, your experience certainly justifies you in bringing this subject up. We might get some information on it. I can't understand how you got into these difficulties. What kind of collector do you use on the trolley wires?

B. H. Kersting: A trolley wire sliding collector, a very good make.

Wray Dudley: And the sliding was more desirable than the cast iron shoe?

B. H. Kersting: On the rigid trolley wire.

Wray Dudley: Gentlemen, there is something for you. You never thought that would ever come back again, but here it is.

B. H. Kersting: It was on outdoor cranes. There is no trouble on indoor cranes.

A. J. Standing: We have outdoor cranes operating from conductor rails with under-running counter weighted conductors. We have some running on angles with under-running V type shoes and some running on bars with twin pick-up cast shoes. They are all getting along successfully. But in the before mentioned shipping yards we put five cranes entirely to bar conductors and in about three months put them back on trolley wires. This was too much for them and to meet the demand we had to put them on trolley wires.

E. H. Aik: I hate to monopolize the floor too much the first time I attend your meeting, but I had an interesting experience on this subject. I have been associated with various crane companies before I was with the present company. At one time I was in Chicago representing a crane company and when I went to call upon a man the first thing he said was, "There is one thing you fellows have that has it all over any other crane we have, and we are going to standardize on it."

He pulled out a drawing and showed me a roller wheel on an inverted V angle. The joke was that when I came to this crane company and saw that design I said, "Don't ever use it again because the bottom side of your conductor is going to get rusted and you can't keep it clean. It is no good." And they quit using it.

I brought up that argument with this fellow. He said, "Come up and I will show you whether they get rusty." It was as nicely polished as any conductor I have ever seen.

The funny part is that we have just installed a large crane on an outdoor runway, 77 feet from the rail to the ground, and we felt we had to get the very best main line conductor on there that was possible. Due to the sleet conditions which we often encounter in Milwaukee, we wouldn't want to be called upon to go up on the 77-foot high runway and knock sleet off the wire. On that particular runway we installed a 3x3x½-inch inverted angle, and we had a roller collector, a double roller collector. It has gone through this winter with very excellent results. The condition of the conductor is very good in spite of the fact that the crane does not run up and down the runway as much as a lot of high-speed cranes.

Wray Dudley: What is the shape of your roller —V shaped?

E. H. Aik: Yes. It does not come up in the bottom of the conductor, of course, but it makes a contact on both sides.

Wray Dudley: How do you collect the current from the roller?

E. H. Aik: Part of it carries through the pin and part of it through the side of the collector. I think possibly some of the improvements which certain manufacturers use such as a spring washer on the side would help the conductor, although we do not have that and have had very good results.

Wray Dudley: That is a new solution.

A. J. Standing: One of the secrets in keeping an under running conductor under the angle where it belongs with the flexibility of the crane is to allow some latitude of play in the arm which goes to your shoe to take care of your current shunt and give flexibility. Otherwise the crane may get enough out of line that the shoes will jump out of angle.

Wray Dudley: We used to turn out cranes with a flat rectangular bar about three-eights of an inch thick with a cast iron shoe riding on there. The cast iron shoe would ride a while and wear a sharp groove and the next time you would start up you would catch your shoes in the groove and you would be left hanging there with no shoes. I think they have gotten away from those rectangular bars.

This question of sliding contact on crane collectors is always with us. A lot can be said. More can be said in favor of the trolley wire than I realized. I wonder if anybody else has anything to add.

W. B. McMasters: On outside conductors, we have a plant close to the Ohio river and had a great deal of trouble with sleet on collector rails. We now use 6" channels, with flanges turned down and cast iron counterweighted under-running shoes and have had very satisfactory results.

On limit switches, we have quite a lot of work that is too large for our buildings, and need every

inch of lift we can get. About nine years ago I made an electrically operated spring closing that permits the hoist to lift to the last inch.

When limit switch is to trip it is only necessary to break the magnetic circuit of the limit switch, this only requires ⅛" to ¼", compared with around 12" in a mechanically operated limit switch. Another advantage of the electrically operated limit switch, is that the operator knows at once if anything is wrong with his limit switch. If there is an open circuit in the magnetic circuit, the switch sets the hoist motor in a dynamic braking circuit the same as a Youngstown switch and hook can be lowered but not raised. I think this is a step forward in safety.

We have some mechanically operated limit switches with weight ropes running over sheave wheels, and as brought out here today, the ropes get off the sheaves and no one knows it until the limit switch does not work.

Magnetically operated, spring closing, double-pole, double-throw switches can now be had from various electrical companies. In ordering it should be stated that two of the opposite arms are to be insulated from each other.

Welding crane runway joints, have found that if joints are badly worn it does not pay to weld. The weld does not stand the wear or comes out inside of a year leaving the joint in a worse condition than before. We cut the ends of the rails square and move together or cut out the bad joint and set in a 3 ft. section.

Safety Limit Stops for Hoists†

By D. C. WRIGHT*

The 1924 edition of the Safety Standards of the Department of Labor and Industry of the State of Pennsylvania call for an approved Limit Stop for hoist motions on all E.O.T. cranes. In 1912, The Electric Controller & Manufacturing Company designed and first marketed the Youngstown Safety Limit Stop. In 1925, the Youngstown Safety Limit Stop was passed upon and approved by the Department of Labor and Industry. It is interesting to note that even twelve years before the Standards became a law, this manufacturer had designed a piece of apparatus to fit the requirements of the law, and were selling it to steel mills and other industrial plants. Up to the present time, more than 5,500 of these Stops have been put in service.

Regardless of laws of various states, we feel that there is a moral obligation on the part of all employers of labor to safe-guard the lives of the employes, especially during these times of mass production when employers are scrambling to make extra dividends and employes—especially those on piece work—are scrambling to make higher wages. During such times, accidents are more liable to occur than during duller times. A safety device of any nature, which might save the life or limb of an employe, is well worth any initial expense.

In its 17 years of service, the Youngstown Safety Limit Stop has proved its dependability, and very few failures have been reported on the large number now in use. The majority of these failures have been traced to improper inspection or improper mounting. No one can expect a piece of machinery or a piece of electrical apparatus to work indefinitely without occasional, or better still, periodic inspection.

I consider that the prime requisite of the limit switch is to stop the motor in **every case** before the hook has entered the danger zone at the drum surface. Entering into dependability of these limit stops are: First, the mechanical design of the mechanism; second, the electrical connections to be used to stop the motor, which connections should be independent of the holding brake, independent of the position of the controller and independent of all trolley wire or bar connections; third, the means of operating the stop at the limit; fourth, the arc rupturing capacity of the contact mechanism to open the circuit in case of overloads or grounds; and fifth, the integrity of the stopping or braking circuit as regards type of resistance used.

The second requisite of the limit switch is the ability to lower out of the limit switch after it has been tripped without having to do anything except to reverse the controller. This is advisable, because it is frequently just as necessary to lower a load as it is to hoist it, especially when handling hot metal.

It is quite obvious that the Limit Stop must act, not only on all hoisting positions of the controller, but also at the off position because many of the electric brakes are rather inoperative in the hoisting direction, and if the operator brings his controller to the off position just before entering the danger zone, the load may drift into the drum. The electric brake may automatically be inoperative in the hoist direction, or in most cases would allow too much drift in the hoist direction on a lightly loaded motor to be relied upon to stop the motor in case of emergency. Therefore, dynamic braking must be used for emergency stopping. The dynamic braking connections must be short and obviously independent of trolley wires, which might open at the critical moment. This requires that the stop mechanism be mounted on the trolley adjacent to the motor. This is a very poor place to mount a piece of electrical apparatus, as it is generally dirty and inconvenient to get at for frequent inspection and is subjected to considerable vibration. This location demands that the resistance for the braking circuit be of the non-breakable type because of vibration, and be of well insulated type because of dirt and grease which might accumulate between inspections. The location on the trolley helps as regards mechanical connec-

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tions to the hoist mechanism. A geared type limit switch is not of the proper type because of the stretching of the cables and the difficulty in re-adjusting the stop position when cables are renewed. An engagement type stop operated by the hook itself, is the only proper type, and, of course, can be mounted on the trolley to advantage. A good many trolleys are crowded in space, and it is to the crane builders' advantage to make the Stop as small as possible. However, the size cannot be reduced at sacrifice of arc rupturing ability and simplicity of operation.

The Stop must be double-pole so as to open the circuit on both sides of the armature and insure proper action, even in case of grounds on the trolley wires or at the controller or on the motor leads. The Stop must be quick-acting to insure that the dynamic braking circuit of the series motor is established before the residual magnetism has died out. The braking resistance must be as low as possible to secure a quick stop on high speed so as to cut down the amount of drift and to give the maximum head room. Yet, the braking current must be held within the commutation capacity of the motor.

Unfortunately, to some degree, most Stops do not operate often, causing moving parts to rust or become gummed with grease and dirt, which might cause failure if left too long in an inoperative position. Therefore, the design should be such as to relieve these conditions as much as possible; dissimilar metals, as rust resisting as possible, should be used for all bearing parts and clearances should be made large.

Springs sometimes break, and should not be used for the operating force of the Stop unless space is provided for a good factor of safety on the spring design.

The Youngstown Stop is designed along all of the above mentioned lines and is simply a double-pole double-throw contactor mechanically operated by the crane hook without shunt operating coils, and is therefore, independent of voltage variations and grounds or shorts on the control system. The D.C. hoisting motor, whether on a reversing system or on a dynamic braking lowering system, is stopped by dynamic braking with the shortest possible electric circuit. Lowering out of the Stop is simply accomplished by the reversing controller giving power to the motor in the reverse direction until the Stop has reset, re-establishing the original connections to the motor that were had before the Stop was tripped.

I might mention that this same Stop can be used on alternating current hoists with slip-ring motors, in which case, when the Stop is tripped, the motor is plugged in the down direction through a limiting resistance in the primary circuit, thus causing the motor to stop quickly and start in the down direction. In case the operator does not move the controller to the off point when the limit stop has reset, the motor will then be plugged again in the hoisting direction.

MOUNTING

Particular care should be taken in mounting the Youngstown Stop so as to put the Stop as directly as possible over the hook, thus eliminating sheave wheels for the operating ropes. Where it is necessary to use sheave wheels, they should be of large diameter and deeply grooved. Careful attention should be given to the design of the hook plate which engages the operating weight and also care should be given to the cable enclosing loop to make sure that the operating weight is held in proper position above the operating plate on the hook.

TESTS AND INSPECTION

Any safety device, however carefully designed, should be frequently tested to see that it is in good operating condition. This includes the Youngstown Stop as well as any other limit switch. I would recommend as a minimum test that each crane operator be instructed that when he starts on his shift, he should first hoist slowly into the limit stop and then lower out. If the Stop acts properly, he should then hoist into the limit at maximum speed and note the clearance when the motor has stopped. These tests should be made regardless of what the preceding operator reports on the crane conditions, and it would be well to make the tests with the floor cleared below the hook. If the limit switch fails to stop the motor with proper clearance at the hook or if the motor fails to lower out of the stop at proper speed or if the Stop fails to reset when the hook plate has left the operating weight, an authorized inspector should be called on the job before the crane is allowed to go into service.

Inspection of the Stop should be made once a week by an experienced inspector who should remove the limit switch cover and clean off any excess dirt, grease or graphite from and around the Stop and resistance. He should then inspect carefully for worn parts including worn weight cables and safety chains, as well as the action of the hook plate when engaging the operating weights. This last inspection should be done while the operator is hoisting and lowering several times, and the inspector should still remain on the trolley close to the Stop where he can easily see the action of all of the parts. The inspector should also watch the motor commutator under dynamic braking action to see that it is not too severe. If the Stop acts frequently in regular service as on low head room cranes, the frequent application of braking at this one particular point may damage the commutator, in which case it might be advisable to increase the dynamic braking resistance.

MAINTENANCE

Such inspection should quickly reveal any parts which are worn and need replacing. However, in average service, very little wear occurs on the Youngstown Stop. The majority of repairs which are necessary are caused by shorts and grounds, and these in turn, are caused by dirt and graphite. These troubles can be eliminated by keeping the Stop clean and the cover in place.

Safety Limit Stops for Hoists†

Discussion

Discussed by

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G. W. Yanney, Chief Engineer, The Alliance Machine Co., Alliance, Ohio.

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E. G. Gerber, Sales Engineer, National Carbon Company, Pittsburgh, Pa.

Harry D. Immel: Pennsylvania is engaged this year in a great safety experiment. Experiments in safety involving as they do human lives can be justified on only one ground. That justification is presented in the situation that had existed in this state up to 1929, with respect to the extent that the Pennsylvania Department of Labor and Industry had been able to contribute to industrial safety advancement. Our previous adherence to legislation and regulation for safety promotion was disappointing to everybody in its accomplishment. It was on that account that the Department felt justified in adopting a new educational plan of inspection and in its promotion of the 1929 industrial safety campaign. It will interest you to know that, that campaign has been so highly successful in the first four months of the year for which it has been projected that already every section of Pennsylvania industry is practically 100 per cent pledged to accident reduction. Since the beginning of the campaign more than two millions of workers have signed the campaign pledge to help prevent accidents; thousands of plant safety committees have been formed where they did not previously exist; hundreds of safety meetings of community scope have been held.

I would impress upon you that with all this the Pennsylvania Department of Labor and Industry remains fully conscious of its obligation as an enforcement agency for safety regulations. You have met here today for consideration of a most important mechanical contribution to reducing the hazards of crane operation. I would not wish to leave with you the impression that we in the Department do not consider mechanical agencies essential to safety. On the contrary, we are convinced that no plant safety program can be fully rounded out without every possible mechanical safeguard provided. It is only that we have come to realize that results in accident prevention are much more substantial when mechanical safeguarding is imposed upon a background of education and the proper safety supervision. Provided as we are in the Department with a state-wide organization to carry out safety policies we feel that this same agency which has heretofore devoted itself to enforcement of safety regulations can equally well perform this other great service of advancing a better understanding of safety problems and impressing the need of safety supervision.

All of our study of accidents in Pennsylvania industry shows the futility of trying to obtain safety by regulation alone. I am especially pleased to know that your study of crane limit switches includes inspection, tests and maintenance. The other day out here in Allegheny County, a crane cable broke with no other weight upon it than that of the chain and hooks. Our state regulation calls for the periodic inspection of crane cables. Investigation of this particular accident revealed that there was a shop rule requiring a weekly inspection of cables. As might be expected from the nature of this accident, further investigation showed that this inspection had been so superficial as to be of no value at all. The cable was so heavily coated with grease and dirt that broken strands could scarcely have been noted. Had it been cleaned and inspection made with proper care it is very likely that its defects would have been revealed and the injury of a worker prevented. Instead, careless inspection provided a false sense of security which probably contributed to the accident.

It is this particularly serious aspect of improper inspection, which must be charged to lack of supervision and need of additional safety education, that I would impress upon you. No matter how mechanically perfect are your limit switches, if they are permitted to suffer derangement unnoted, sooner or later some crane operator, counting too much on his limit switch to avoid an over hoist, will bring upon your plant a serious accident.

I don't know of any greater hazard in industry or out of it than a safety device that fails to function. We are becoming more and more prone today to trust ourselves to the mechanical safeguards that are thrown about us. Stop for a moment to consider how much dependence you place upon the brakes of your automobile. Over in southeastern Pennsylvania a dangerous railroad grade crossing

†Presented before Pittsburgh District Section, A.I.&S.E.E.

was quite recently eliminated. A few years ago, because of the number of accidents at that point, the railroad company conceived the idea of stationing a watchman there during daylight hours, when traffic was heaviest, to supplement its signal bells. Almost immediately accidents at night became more numerous. Persons accustomed to travel over that highway, noting the presence of a watchman during a portion of the day, began to place all their dependence on him.

In a surprisingly large number of cases we have found manufacturers, who were called upon to do extensive safeguarding, greatly disappointed because that safeguarding did not materially reduce their accidents. An executive of one of the large industries of this state told me that some years ago they were having a great many accidents and determined to provide every possible mechanical safeguard to prevent them. He said that after this guarding had been done he was amazed to note that there was actually an increase in accident frequency, although severity had been somewhat reduced. That concern then established a safety organization, concentrating on education and better supervision with a much more gratifying result. The great problem in industrial accident prevention today is how to make the individual worker a safe thinker.

In Harrisburg recently I personally noted on an advertising sign on top of a building on the main street a scaffold so faulty in construction that even at that considerable distance its hazard was apparent to me. The inspector I sent there a half hour later arrived just in time to see one of the men who had been working on that scaffold being removed to the hospital with both legs broken.

When the Delaware River bridge was under construction one of the workers sat out on a beam and then proceeded to saw off his support and fell into the river and was drowned. Another worker in Philadelphia had an eye put out because he removed the lens from his goggles with the notion that he was defeating a shop regulation.

In northeastern Pennsylvania a rat ran into an almost empty carbide barrel and one of the workers conceived the idea of throwing some water into the barrel and following it with a lighted match. The barrel exploded and killed the worker.

In southeastern Pennsylvania the other day a worker was closing packing cases so carelessly that he found after one blow of his hammer that he had nailed a finger fast to the box.

In Pottsville recently a distressing fatality to a young worker was caused by a practical joker who attached an electric light wire to a dinner pail.

These are only a few accidents called from thousands that we review every week, which illustrate the great need of safety education as a background for mechanical safeguarding.

The last case I cited should, I feel, be more significant of all to you, as electrical engineers. Nothing is more disturbing to us in the Department today than the increasing frequency of accidents from what are termed "low voltages." They indicate a grave lack of understanding by the average individual of the hazards of electricity. I was much impressed recently when the Westinghouse Electric & Manufacturing Company submitted to me for publication in our monthly bulletin photographs and a description of a step-down transformer for use in their own plant to reduce the voltage carried by the cords of extension lights. The last time I was in Pittsburgh I read in a newspaper of the electrocution of three persons in the cellars of two houses in Biddle, near Greensburg. One woman was killed when the globe of an electric light extension broke and her husband was killed when he attempted to save her. Only a few blocks away another woman met death in her cellar by touching an uninsulated wire.

I consider that Westinghouse device an important step in the direction of frank recognition of low voltage hazards. I asked one electrical engineer recently whether it would not be feasible to step-down voltages generally for practically all household and at least some industrial uses. He admitted that it would be feasible, though it would involve considerable expense for new equipment. Perhaps you consider this to be too visionary. Maybe it is at the moment, but I would ask you to consider that it is to the visionaries that we owe the great iron and steel industry of today with which you are associated, as well as all of the other industrial progress which has brought to Pennsylvania its present supremacy.

R. M. Hussey: Crane limit switches are applied in a steel plant to a group of machinery under which either every workman in the plant passes sometime during his turn or, by reason of some men passing under them several times during a turn, the number of trips under the crane will be the equivalent of a trip for every one of our plant force. We are, therefore, concerned with a machine which has to do with the safety of every man in the plant, and for that reason anything that can be done to safeguard crane operations should be done, and done well.

The safety switch we are particularly interested in is a switch as Mr. Wright has described, and not a safety switch that works on control circuit alone —or works on control circuit at all. The safety switch we want is that switch which functions one hundred per cent as a hoist limiting device in case power should fail or in case of control trouble, or in case of negligence on the part of the operator. In other words, it shall operate by itself, automatically.

Location of the Switch

The switch should be installed in the most convenient place, that is, on top of the trolley, if possible so that it may be readily installed and also accessible for inspection. Care should be exercised in locating the switch and installing the switch so that there shall be no accumulation of dirt, or, as has already happened in one of our plants, no accumulation of snow under the weight mechanism which prevented the switch from functioning properly and allowed the blocks to be taken to the top and jam. The switch should be so located and installed that it will be secure in every way. We are just as much interested in parts not falling off safety switches as other parts of the crane. Counterweights or other parts of the crane limit switch which may at some time get loose and fall, should be secured by a loose cable or chain fastened to some part of the structure.

Operation of the Limit Switch

One very important thing we have to take care of is allowing for the proper amount of upward

drift, and a little more, in order to have a margin of safety. In this same connection there enters another important thing; that is we should watch changes in design of burden blocks and spreaders that may be used from time to time, especially in cases of spreaders used at right angles to the crane girders. If a limit switch is set for a certain design of spreader, set at right angles to the crane girder, and the mill people change spreaders, the bolts and lugs on the new spreader being shorter, then the adjustments of the crane limit switch for the first spreader will be too close and will, therefore, create a dangerous condition in that the new spreader may hit some part of the bridge girder before limit switch can function. The crane limit switch should operate automatically and should not depend on a source of outside power for its proper functioning. It should be so designed and set up that it will reset automatically when hoist is lowered; otherwise the craneman would probably have to go on top and set the switch by hand or ask a motor inspector to do it; and with such operation you would soon find limit switches so tied up, or fastened, to save the cranemen this work, that the limit switch would be inoperative.

Inspection and Tests

The limit switches in the plant with which I am concerned, in the Aliquippa Works, are inspected every eight to ten hours, as the case may be, depending on eight or ten hour operations. They are tested at the start of each turn by the craneman actually running the hoist up and causing the safety switch to function and stop the hoist. Every two weeks the general foremen are catechised in a meeting and pertinent questions are discussed in connection with condition of their limit switch equipment. These limit switches are maintained by the Electrical Department; the work being done by motor inspectors. Repairs have not been frequent. Some troubles were experienced at the beginning, but have since been ironed out and satisfactory operating conditions have been obtained. There were some bearing troubles at first, but this reflects back on a former lineup of inspection and test work, in that switches were not properly inspected and were not operated often enough to keep them limbered up. We experienced several cases of trouble due to sleeve bearings becoming so gummed up that the operating mechanism did not rotate. I believe it is now the common practice to use roller type of bearings in one make of crane limit switch, and I think all of our switches of that make have been changed to use roller bearings, and since that change was made there have been no failures due to any bearing trouble. There have been some breakages of cast iron parts, but this condition has since been corrected by the use of steel casings and forgings.

In this plant there are about 140 cranes, and there are 153 limit switches on those cranes; all of them being of approved type manufactured by limit switch manufacturers, except in the case of 11 switches. We have 11 switches of our own design. I think most everybody has a few switches of their own design. There are probably good and sufficient reasons for having 11 switches of our own design; there are several cranes where the head-room is actually too low to permit the use of any one of two or three manufactured switches.

G. W. Baumgarten: The subject assigned to me was "Maintenance of Limit Switches." I have listed the parts of a limit switch which may need maintenance so that we may take them up in order. The list is as follows:

contact tips
arc chutes
shunt leads
insulation to ground
register
cable
bearing lubrication
tripping weight
result of bearing wear

We find that the maintenance of contact tips, arc chutes and shunt leads is a comparatively simple matter even though a large number of our hoist limit switches are tripped each time a lift is made.

Formerly, the insulation on the arm carrying the contacts was composed of a black fibrous material which failed very easily after being exposed to graphite particles. The black fibrous material was replaced with red fibre which was given a coat of shellac. This eliminated our trouble due to grounds.

The standard cable furnished on our hoist limits is 3/8" in diameter. This had to be renewed quite often so that we now use 1/2" cable. The groove in the sheave wheel was sufficiently large but the clamping device had to be changed.

We build our own resistors and have designed a set of resistors to be used with hoist limit switches for various sized motors. Maintenance on the resistors consists of taking up the slack in the through bolts due to alternate expansion and contraction. A sheet steel cover protects the grids from the weather and prevents the maintenance men from standing on the resistance bank.

There is no means provided by which the limit switch bearings can be lubricated at the present time. Most of the oil runs into the bottom of the case and collects graphite.

We recommend that some method be worked out whereby the bearings may be oiled from the outside of the switch case. A better method would be to install anti-friction bearings arranged for grease lubrication.

The method of securing the tripping weight caused considerable trouble due to the wearing out of the clip which generally allowed the tripping weight to swing to a position where the rope block would not trip the limit switch. In order to eliminate this difficulty we built a tripping weight which consists of two closed loops of 2" round bar 20 1/2" long by 6" wide. These two loops were welded to each end of a piece of 4" round which is 6" high. The round section is located at the center of the loops. One or more ropes may pass through this tripping weight on each side of the 4" section. This prevents the tripping weight from swinging out of line and due to the size of the material in the loop eliminates the possibility of a loop wearing out.

Bearing wear is probably the largest source of trouble on a hoist limit switch. The weight which opens and closes the switch contacts is overhung on the switch bearing and since no means are provided for oiling these bearings they soon wear to the point

where misalignment causes the switch to jam. This caused a number of failures which resulted in an attempt to eliminate the misalignment. An outboard bearing to support this overhung weight was attached to the switch case and eliminated all our troubles. We now add this outboard bearing to all our hoist limit switches when they are overhauled in the shop.

In conclusion I wish to emphasize the necessity of proper bearing lubrication and the elimination of the overhung weight. If these two improvements are incorporated in the present hoist limit switch they will reduce the number of switch failures considerably.

O. S. Jeffries: I just came here to listen and learn. We run up against all kinds of trouble on the road. People turn it over to us and we work the thing out. I would like to see a state law passed for every crane to have a limit stop on of some kind. Every engineer can put some stop on there. If he can't buy a standard, he can put one on of his own make. A 2x4 will make a good serviceable stop to prevent accidents. Also, we have quite a number where we use headway limit stop. This we find very convenient on strippers and soaking pit cranes. Where putting in hatch way limit switches, I would suggest to put two in series. We can depend on them. With the old band type brake, where you get a drift, the old open circuit type is not much good; but with brakes we are putting on today, an open circuit is about as reliable as anything. The band brake should be prohibited by law. It is criminal to install a single band type brake on a crane hoist today.

G. W. Yanney: I was interested in the subject of limit switches, as we are using them on practically all of the hoists on cranes. We are responsible in a way, for some of your 2x4s which were practically the only form of limit stop in use for several years, and in fact served its purpose very well until later types were put into service.

The matter of mounting the limit stop, especially the type with operating weights, is of great importance and it has been our practice to place these stops as near the center of hoist as possible so that it will not be necessary to use any extra sheaves. Where it is necessary to use extra sheaves we aim to guard the cable so that it cannot get out of the groove, as we know where accidents have been caused by cables getting off sheaves and becoming fouled in such a way that the stop would not operate even though the weight, itself, was raised by the block.

I am very glad that I have had the opportunity of hearing the different comments with regard to limit stops.

Walter Greenwood: Replying to the interrogatory remark, how are we to differentiate between using the tell-tale device necessarily and unnecessarily. Unfortunately we have too many installations where clearance is not sufficient, where we must manipulate the limit stop to make the necessary lift. With the tell-tale device we would know if the limit was brought into use and if we had a suspicion it was used unnecessarily, we could make inquiry by reading the tell-tale device and then get an explanation as to the necessity for making use of it if there was any. Unquestionably some operators are prone to make a utility of a limit stop if they think they will not be detected, and there is no way to prevent this unless you apply a checking device to determine when they are doing it. Of course, if operators are called to account for violating instructions they are not likely to repeat the offense.

It would seem from some remarks I have here listened to, that inspection could not be very thorough if equipment is permitted to deteriorate so far it fails before repairs are made. I believe the regular system called inspection is to run the hoist until the block operates the limit. Such a method is no inspection, but I believe it is resorted to more often than any other method and is called an inspection. The limit may be in such condition that it is about to fail but will operate so long as it will hold together, and it may fail immediately after inspection by this method. It seems that if a limit switch was inspected as it should be, accumulation of dirt from any cause whatever would be insufficient to impair it, and wear and tear, if serious, would be repaired before failure occurred. I also believe that one of the troubles in regard to failures of limit switches is, real inspection is not made that is as thorough as it should be. The time required for making inspection is not likely to delay operations. We should not wait for failure to occur if there is a worn part or any condition that might interfere with operation of the limit.

John A. Oartel: I came here because of my interest in safety; because electrical apparatus is becoming more and more the burden of the safety engineer and some of them do not know much about it, in which class I am. In other words, there are going into our steel mills more and more electrical devices. We can't stop them; we do not want to stop them; so the best thing we safety men can do is to learn as much as we can by coming to meetings like this.

This Association about a year ago conceived the idea of forming what is known as a Junior Membership, which appealed to our people very much. We have as members of this Association, the technical electrical engineer, the combustion engineer and the safety engineer. We have those three different branches of the Association, which is all very good as far as it goes. Those people in a great majority of cases know their stuff. Then out in our mills where we come in contact with practical things, we have men operating our cranes, men known as motor inspectors, and men in electrical gangs that we are just a little doubtful about as to how much they know about electricity. So this Association which is always in the forefront, always keeping up with the times, conceived the thought of getting these fellows into the Association and getting something for them, so they organized this Junior Membership. As I say, it appealed very much to our people. About that time something happened. It came under my observation that it was a good thing to go down into the rank and file in our steel mills in the electrical department and teach them something more than they already knew of things which came within their conception of electrical devices they were dealing with. So I want to describe the failure of a limit switch as best I can without touching much on the technical steps of the thing. This particular limit switch consisting of tripping mechanism, sheave

wheel, tripping device or counter weight, and idler pulley which was put together by well meaning men; men who were given a job by their foreman, were thought competent and they went out and did the job. The idler pulley was supposed to be located where the cable would function over it. After this accident and a very thorough investigation, it was found the idler pulley had been fouled, or, in other words, the cable, had been put in on the wrong side of the idler pulley, and when occasion came to operate it jammed. So when this program was sent around to me I commented on the installation of electrical devices of different kinds; and I do think this Junior Membership which has been inaugurated by this Association will, when it gets to work and the men are better acquainted with the fundamentals of electricity, perhaps prevent a thing like this.

Want to say, as far as I know about the construction of limit switches, our company installed them very early in the game. We have used a lot of them and with a few exceptions they work fine. They need to be installed properly and they require a lot of inspection. With the many electrical devices in our steel mills, the technical engineers should feel they are ahead of the game, and we as safety men are lagging a little. I was speaking to my boss the other day in connection with an accident. In the old days of working in the mills when a man wanted to borrow a tool, he went to his buddy and borrowed a hammer or a wrench, which was a harmless tool and he could not do much damage if he did not use it right; but today he goes to his buddy and borrows a dangerous thing. So I think we safety men are a little behind in our inspection and in taking care of these intricate electrical and mechanical devices that have come into our mill.

In the old days we had a horse and buggy and could throw the reins on the horse's back; today you go home in an automobile and should keep your hand on the steering wheel and your eyes on the road.

A. J. Acker: To me the point just brought out about the wood of a 2x4 Limit Stop crushing and thus serving as a buffer between the lower block and the trolley is a new virtue of this type of stop. This makes me wonder whether it might not be a good idea, at least in some cases, to provide a place on the top of the lower block, or underneath the trolley, or possibly on both, for bolting on pieces of wood just for the purpose of serving as buffers. There are some obvious objections that would be raised at once to this idea but it might be of advantage in some extreme cases. I would like to hear what the maintenance men here would say to that?

C. L. Baker: I agree with what Mr. Oartel said about the safety engineer keeping up with the job. That is the reason why the Association of Iron & Steel Electrical Engineers several years ago thought they ought to get busy on the safety problem, at least more active than they had been, to bring the safety engineer in touch with the mechanical engineer. When we go to produce a new piece of machinery, crane, mill, or machine tool, one thing every chief engineer invariably does: He calls in the safety engineer and talks with him about the safety situation, not that the safety engineer can tell him something or answer any technical questions, but he always feels that the safety engineer can probably give him some idea he can incorporate in this machine, or some idea in regard to installation, or bring out some things to him that he has not thought of in the way the man will work with the machine. We have found it good practice. It has brought about a closer relation between the inspection department and construction work in the installation of a new device. I believe that is the way we safety engineers can grow and become more intelligent and better foresighted in trying to follow safety through the intricate phases both electrical and mechanical. We have to do it in the steel business.

I do not believe there is an electrical engineer or a manufacturer here this afternoon that won't say his people from the top down are giving more attention to building, equipping, location and everything that comes about in the way of new building, new construction, to make working conditions better and safer for the man who is going to operate them. For after all that is as it should be. It is a matter of dollars and cents. Forgetting about the human proposition, if a man is killed or injured, it costs money just as though it had been spent on repairs. I believe if we think of that phase a little more, our safety work will go much farther.

G. W. Baumgarten: What is your idea on lubrication of out-board bearing?

D. C. Wright: Your suggestion for out-board bearing is good for the present designs of stop. The failure Mr. Hussey mentioned when snow got under the tripping weight is new to me.

This objection could be overcome by putting the tripping weight under the cover to exclude the snow.

The limit switch is up for re-designing and has been for several years. All these points these gentlemen have brought up are well thought of.

A. J. Acker: Many people object to two dangling weights. One could be replaced by springs, but there are lots of objections to springs. I would like to ask whether we are to depend on guarantee for operating plans or depend on springs?

G. W. Baumgarten: What is the objection to two weights?

D. C. Wright: We don't object to the weights, but to sheave rope breaking and dropping 30 or 40-pound weights. If the hoist cable enclosed in cable loop and your sheave rope breaks, your weight will slide down the cable. There has been a case or two of trouble where the safety chain has become kinked and keep the weight from going down. In the resetting, the motor is operated as series motor, during the short interval the stop is being reset, and motor speeds up, possibly, to a little higher speed than after the stop is set. We have had a few complaints of that nature. I do not know whether you gentlemen object to such a speed during the resetting of the stop.

It is pretty hard to furnish a proper weight with every stop from the manufacturer, because stops are frequently installed on cranes where it isn't possible to get direct connection up to the stop, in which case you need a heavier weight to overcome the friction on those sheaves.

A. J. Acker: In what percentage of cases can limit stop be located directly over the load? It requires a lot of care in replacing that switch, but

very often in more than 50 per cent of the cases, we have to use one or more idler sheaves.

O. S. Jeffries: About 90 per cent, approximately, over the top, and put roller bearings in sheaves, and we have no trouble.

Walter Greenwood: Is it a matter of importance to have a safety chain on a weight to prevent it from sliding down on cable if it becomes detached from switch? If it would release from the switch lever it would go down and damage the sheave or sheave wheel and possibly would injure the cable.

D. C. Wright: You can put it on the side. As a safety chain on the weight operated by a hook, I have not heard of anyone applying that.

Walter Greenwood: If it would not release from the lever it would go down and do damage to your sheave pulley.

D. C. Wright: Two safety chains, one on each weight, would not prevent operation. Except with another chain dangling near the cables, we would have to take means to keep it away from the hoisting cables.

I think that sketch by Baumgarten showing enclosed loop on the weight is a very good scheme to make block hit on the operating weight.

Walter Greenwood: Has any steps ever been taken to make the switch operate, say at the speed of the motor?

D. C. Wright: That would require some complicated switch mechanism, and as one of the engineers brought out it would be too cumbersome to go on the trolley.

Walter Greenwood: Would many of the accidents occur from that?

D. C. Wright: That would be difficult to answer.

Walter Greenwood: When that does occur, it is impossible to find out what happens; nobody will confess they are guilty.

G. H. McFeaters: Wherever dynamic is employed or any form of electric, and usual grid type of resistance even, there is a possibility of steel breaking; but there are a number of good alloy resistors, such as E.M.B. and some more of them.

D. C. Wright: I agree with the gentleman that resistors should be non-breakable. We furnish a steel tape resistor well enclosed, and I have not heard of any breakage. I would like to hear if anyone has had any trouble from open circuit on the resistance we furnish or any other troubles.

A. W. Mohrman: How high would that crane reach on 50 H.P. hoist?

D. C. Wright: We have practically instantaneous braking after the motor circuit is opened. We allow from 50 to 100 per cent overload current to flow on braking.

O. S. Jeffries: I find in some plants they blow graphite accumulation around a plant away with an air hose. This gets back into contactors and gives a lot of trouble. Most of our trouble has come from that cause.

Harry D. Immel: Recently, and I think it was out here in Pittsburgh, I heard a humorist say, in the manner of some statisticians, that if all of the after-dinner speakers in the country could be laid end to end what a fine thing that would be.

Mindful of the implication in that statement; mindful, too, that I have been told that the iron and steel men are "a hard boiled lot," I am going to try by brevity to keep fairly well in your good graces. I am going to tell you about an accident prevention experiment that is being tried in Pennsylvania this year.

Experiments with accident prevention, involving as they do human lives, are serious things and can have only one justification. That justification is presented in our experiment through the fact that the lines of safety promotion that we heretofore have followed in the Pennsylvania Department of Labor and Industry, mainly enforcement of safety regulations to obtain industrial accident reduction, have been disappointing in their accomplishment. We, therefore, felt justified in making this experiment, which includes a new educational plan of factory inspection and safety education campaign. It is the largest in its scope that has ever been undertaken and covers a period of this year. In the first four months of this campaign, it has been successful beyond all our expectations. So far we have had in this campaign, the signature of individual workers to more than two million of safety cards, pledging themselves to help make this accident reduction campaign a success. We have through our friends, aided by friends of safety engineers who have given good service in this campaign, succeeded in the formation of thousands of individual plant safety organizations where no plant safety conditions existed before. We have already had in the hundreds, safety meetings of immense scope. When Mr. Baker extended me so kindly the invitation to be here tonight, although this campaign crowds me with duties, I felt I could not resist the opportunity to come and meet with you, many of whom I have not had the opportunity to know, personally, heretofore.

I would not have you think from what I have said to you of our new education plan, that we no longer believe in mechanical safeguarding. We are mindful of the responsibility that arises within the Safety Department of Labor and Industry for the enhancement of industrial safety through regulation and for the promotion of mechanical safeguarding. You have come here today for discussion of a most important topic, safety of crane operation. We in the department have the conviction that mechanical safeguarding is absolutely essential to any well conducted plan of safety. But we have been forced to believe that mechanical safeguarding is only a preliminary step of safety and prevention of accidents. We have, therefore, taken this organization of ours which is state-wide and which heretofore has been largely devoted to efforts in mechanical safeguarding and undertaken through it, with the help of the safety engineers of this state, to promote safety education and to show the value of safety supervision.

Our study of accident records in this state impresses us with the futility of trying to get safety through mechanical safeguarding alone. I am very glad in your discussion of "Crane Limit Switches" you have stressed the importance of inspection. Recently in Allegheny County, a crane cable broke with no other weight than the chain hooks and a man was injured. Our investigation showed that there was weekly inspection of crane cables in that plant, but further investigation showed that the cable was so encrusted with grease and dirt that the su-

perficial inspection that it must have had would scarcely have detected broken strands or any other evidence of weakness; and that I would point out to you is the great danger in mechanical safeguarding. That particular condition because of the fact that there was inspection became an added hazard. The feeling of security from the fact that there was inspection would lead the operator to take chances that he ordinarily would probably have avoided. The crane limit switch on which the working force are dependent for a certain amount of security, if it fails to function for any cause, naturally must be an added hazard. Our accident records are full of cases where cranemen have taken risks where they were seemingly over confident in the reliability of mechanical safeguards. We are prone to depend on mechanical safeguards that are thrown about us. Have you ever thought of the dependence you put on your automobile brakes and stop-light when you put your foot on the brake and signal to the driver behind that you are slowing down to stop. On thousands of those things we are depending on continually and if they don't function, there are accidents.

A grade crossing which had been recognized as a death-trap, was provided with signal lights. The Railroad Company decided to put a watchman on duty there during the day-light hours because traffic was greater, and immediately more accidents than before began to happen on that grade crossing. Persons accustomed to using the crossing knowing of this new safeguard provided by the presence of a watchman, and not realizing that the watchman was not there at night, went ahead and met with accidents.

You would be surprised I am sure, at the number of executives, who, even today, are willing to place their full dependence on mechanical safeguards when they have other regulations. Again and again we will ask a manufacturer to do safeguarding involving considerable cost. Probably he will comply and will be grievously disappointed because his accidents have not been considerably reduced. I talked recently with an executive of a large concern, who said that their accidents had reached such proportions that they decided to provide every possible mechanical safeguard; and he told me after all this safeguarding had been done, their frequency had increased, although severity was somewhat reduced; and then adopted a safety organization with much more gratifying results.

I do not need to say to many of you men here tonight that after doing all the mechanical safeguarding we have done, safety education is after all our first problem, and to do the mechanical safeguarding and to leave the supervision and education until after everything is done is "putting the cart before the horse."

Not long ago in Harrisburg, I looked up to see a scaffold being constructed for an advertising sign and could see immediately that the scaffold did not comply with requirements. In the half-hour required to go to the central office and back, we arrived only in time to see one of those workers carried away with both legs broken. Those men failed to recognize its hazards, and had we arrived before the accident they would have said that we might be engaged in better business than interfering with men's work, that they had worked five or six years on scaffolds of that sort and could keep on working with such experience.

An old gentleman, in Eastern Pennsylvania, head of a concern of considerable size which had been built up through his efforts, had a call from an inspector of an insurance company, who brought to his attention the safeguard on a machine, I think a planer, in his wood-working department, and the old gentleman said he did not see the need of a safe-guard, that he, himself, had operated that machine for 30 years, but would look it over. They looked it over and an employe turned on the power —the machine was idle. The inspector told him that was not necessary, but the employer then undertook to show him its method of operation. That inspector was in my office the next day. He said in the next moment there was a rendering sound and he was splattered with blood and the man was standing there with the stump of one hand; his hand had gotten into the knives as he was attempting to demonstrate the safety of that machine. That is entirely a too common attitude in industry, and I feel from a safety inspection standpoint, one of the most difficult we have to deal with. On the Delaware River bridge, a workman sawed off the beam he was sitting on. A man had an eye put out in a shop where goggles were required to be worn, and had removed the glasses to keep from complying with the shop regulation. Not long ago there was a case of a man who had been shutting packing cases and had nailed his finger fast to a packing case. These cases were due to heedlessness and a lack of education that we are trying to impress on the worker. Another case reported from Northeastern Pennsylvania, where a rat ran into the bunghole of a carbide barrel and a man thought it would be a good way of getting rid of the rat by pouring water into the barrel and lighting a match to it. In Philadelphia sometime ago, a man attached a wire to a dinner pail. That last accident I want to stress to you electrical engineers in industry. We are gravely concerned in the Department of Labor and Industry over the increasing number of electrical accidents in industry, accidents that are occurring on so-called low voltages, and it is our conviction that industry, as well as the general public—and when I say "industry," I mean the individual worker who has only the layman's superficial knowledge of electricity—must be educated to have proper respect for electric current.

To Electrical Engineers, I do not think I could stress my message any better than to cite an incident which always comes to my mind when I talk about electrical hazard. The late Dr. Charles P. Steinmetz, who was then associate professor in the electrical college, in his laboratory, invariably opened his switches with a stick the length of his arm with raw-hide "frozen" on the end, which was his plan to teach others to have a proper respect for danger inherent in electricity. He could not have given any better lesson than his own application of that sort. Limiting devices, although they naturally in industry concern me most, are not the only hazards. The other day a man came into my office with a brass screw. If that crooked screw had been one-eighth of an inch shorter a man's life would have been saved that was taken. A screw from the plate of a

conduit used in an industrial attachment was used by somebody with old-fashioned electrical equipment and had screwed wires into the conduit and the additional length of screw carried it beyond the inner shoulder which caused the conduit to be electrified and gave no consideration to having efficient test as to whether insulation was broken after job was completed, and the man in disconnecting the conduit was killed. Accidents of that type are occurring daily and I leave it to you whether it isn't possible through education to decrease them.

The Westinghouse Company sent in to me for an opinion on some photographs of step-down transformers which they had made for use in their own plant, to reduce voltage on electric light extension cord; and it occurred to me that, that was a splendid example of the manner in which electrical people can show the importance they attach to the need of caution in the use of electrical appliances. I think the day is not at all far away when electric power concerns will disseminate that sort of information to everyone generally. Last December, three deaths occurred in one day because some persons were not familiar with the hazards of electricity in the homes. A man and his wife were in the cellar with an extension cord light; the woman was fatally shocked and the man in coming to her rescue was also fatally shocked. In another case a man had touched an uninsulated wire and had been killed. That sort of fatalities we are having in great numbers. That experience conveyed to me that there possibly was something that could be applied to homes. I asked an engineer of experience whether there was not a possibility of reducing voltages to a safety limit, and he told me it would be but that there would be considerable expense involved in making the necessary changes in appliances.

When we consider these accidents, I feel we do not need to file apologies for being educational. We have been going ahead trying to accomplish what we can. We need education that some of you safety engineers are applying with splendid effect to your own tasks. I ask you to keep this thought with you as you go back into your own plants, to help not only to make this 1929 campaign a success, but help us to reduce industrial accidents.

John A. Oartel: I move that this Association of Iron & Steel Electrical Engineers endorse this statewide educational campaign of the Department of Labor and Industry, for the prevention of accidents. Motion seconded and unanimously carried.

Harry D. Immel: I deeply appreciate your endorsement of this educational campaign, and thank you on behalf of Secretary Waters.

C. L. Baker: The Department of Labor in Ohio are putting on a similar campaign, and I wish to say to you men here from the State of Ohio, that we hope you will back the campaign in Ohio just as we are in Pennsylvania. They are trying the same procedure as is going on now in Pennsylvania.

I announced this afternoon that Mr. F. W. Cramer, First Vice President of this Association, was going to discuss a feature of this limit switch proposition. I just have word he can't be here tonight, and he has asked me to have this question discussed:

"I would like to have discussed the actual time required for a switch and motor to function. I have often wondered if the speed of the hoist was given, if the manufacturers would contribute figures that would show the minimum hoisting distance in which they would guarantee stopping the lift."

Mr. Cramer was formerly connected with the Bethlehem Steel Co., at Johnstown, and is now Chief Electrical Engineer of the Republic Iron & Steel Co., and would like to have some expression on this question that he intended to discuss personally.

D. C. Wright: I hardly see how it is possible to give any definite time for stopping the motor if the speed of the hoist only is given. For instance, you may have a 5 H.P. motor and a light gear reduction and, say, a 30 ft. per minute travel of the hook. The inertia of your motor and your gearing will be rather light. Again, you may have a 100 H.P. motor, a heavy gearing and still have 30 feet per minute travel. The time for stopping depends upon the inertia of your motor and gearing and upon the speed of the motor rather than upon the speed only of the load. The 100 H.P. motor would have more inertia and would take a longer time to come to rest under dynamic braking action.

In another case you may have two hoists with the same size of motor but one motor may have a considerably higher full load speed and a higher gear reduction. The inertia of the armature on the high speed motor may be less than the inertia of the low speed motor, but the time required to stop may be considerably different because of the difference in speeds. Possibly, the time required to stop might be the same, but I cannot say what it would be without definite calculations for each case.

Again, we may have two hoists with the same speed of the load and the same speed of the motor, but with motors of different makes. One motor may have a considerably higher inertia than the other, and would, of course, require a longer time to stop under the same dynamic braking conditions.

It is, therefore, seen that it is impossible to state that all hoists having the same speed of the load, can be stopped in the same time. In general, with dynamic braking, it has been my experience that on light loads, even with fast operating hooks, it is practical to stop the hoist in from 15" to 18" of travel.

R. M. Hussey: I think Mr. Wright has stated it very clearly and concisely, and, I know, a lot better than I could. When the question was first described, I thought of the inertia load, and that the inertia, or stored up energy in the revolving parts, together with the light loaded hoist, would be the determining factor in making limit switch adjustments. I do not see why, or how, any manufacturer or operator would want to undertake a guarantee of a certain distance or of a certain time of limit switch operation, for the simple reason that motors, which are mill type motors, can have apparently the same rating, yet the amounts of armature inertia are known to differ widely; and unless this condition is taken into consideration, and unless the characteristics of the free running motor and the revolving parts are known, I do not see how a guarantee that would cover all conditions could be made.

In regard the use of extension cords for portable lamps around industrial plants, in connection with what Mr. Immel mentioned about fatal shocks from

low voltages, is there a transformer on the market, as a standard commercial product, that could be adapted to the 110 or 120 volt circuits we have in the mill and give a voltage on the secondary side that will permit using the type of lamp used in the Pullman car service? Is there a transformer, as a commercial product, for that very thing?

Harry D. Immel: I do not know. This was the first time that this thing had been brought to my attention. They have 110 volts reduced to 32. I do not think it is on the market. It is a little portable arrangement with space to pack cord and lamp right in the box. There is a handle on the box. Our next issue of "Labor and Industry," will contain photographs and a description.

John D. Scully: I would like to ask Mr. Immel what ruling the State has on riggers' open torches around industries? Also, whether any of the operating men can tell me of any plan they have worked out to provide battery lights in place of extension cord?

Harry D. Immel: Regarding open torches, our only regulation is that where explosive dust or vapor is present, vapor proof lamps are required.

John D. Scully: Recently a man backed into an open torch and met with a fatal accident. It looks like a good-size job to provide extensions all over the plant. I just wondered whether anybody had worked up a satisfactory battery light for places which would require expensive wiring to provide extension lamps?

E. G. Gerber: The Union Carbide Company put out a lamp used extensively on the railroads; it is standard on the B. & O. and other roads. It is a carbide lamp intended to take the place of the oil lantern. One charge of carbide (one quarter-pound) will burn 8 hours. It is on the market in two sizes. It is largely used for car inspection, that is by the "wheel knockers" when a train pulls into a terminal. It is also used in subways in New York City.

C. L. Baker: That might be a good thing to replace the oil signal lantern used by trainmen.

The State of Pennsylvania will put on in Harrisburg, the 1st and 2nd of May, their annual meeting of executive engineers of all descriptions; men that are connected with industries all over the state. It will be a two-day meeting on safety. Their program is well under way and they have some of the most prominent men in our state, as well as outside of the state, who will discuss different phases of industry and endeavor to better conditions in our own state.

I sometimes think, as steel people, we pat ourselves on the back and imagine how good we are, but sometimes fail to do our job when it comes to our neighbor, the small industries in the state of Pennsylvania; we expect their rate of insurance to carry them through in safety measures. They get the idea if they have their men insured in some company that is about all they need to do, because they think if they are carrying insurance on their employee they have gone just about far enough. I wonder, as men who are interested in industry, if it would not be a good thing to be a little more cooperative with the small manufacturer. We buy things from him; we sell to him; isn't it up to us to help him along in these things when we are able to do so. I think when the steel industry takes that attitude in Pennsylvania, they will help the state wonderfully. It takes money to run the government, and the less we have to pay out for the unnecessary things, the more money everybody is going to have; and I bespeak for the state your interest in the meeting that they are having in Harrisburg. This is an iron and steel affair. Mr. Immel and his men in the state of Pennsylvania need your help; they are asking for it and doing everything in their power to help you; so one good deed deserves another. Keep them in mind and when you get communications in your shop or factory asking for information on a code, give it prompt attention. They are right in Harrisburg; you can help them a lot if you will take a few minutes to think about problems they are facing, and just consider their problems are yours.

I wish to thank you for your attendance here today. We have heard discussion on safety that is vital to all users of cranes, and I hope electrical engineers as well as safety engineers will go back into their plants and give serious thought to the problem of hoist apparatus on cranes as to ways and means to make it safer. We are sure there is such apparatus on the market. It is working, as you have heard from different sources today, very satisfactorily. We are not here to advertise any particular device, but the fact remains that there are devices and it is up to us as an industry to use them.

Hoist Travel Limits on Overhead Cranes†

By WALTER GREENWOOD*

The importance of providing devices for limiting travel, speed, pressure, temperature or any active forces, has been recognized from the earliest application of mechanical principles to industrial pursuits. Control governors are also limiting devices; release valves are pressure limiting devices, and temperature rise is limited by thermostatic control. If limit of travel of passenger elevators was dependent on the human element they would be very dangerous pieces of equipment. In the application of travel limits devices within the plants for producing iron and steel, few installations for protection from accidents have been of greater importance than has hoist travel limits as applied to overhead traveling cranes.

In the early days of the boom movement for safety demand was made, by safety engineers, for installation of hoist travel limits on all overhead cranes where there was a possibility of accidents from breaking of hoist cables because of failure to stop the hoist at the proper time. Notwithstanding construction of limit devices has been considered

†Presented before Pittsburgh District Section, A.I.&S.E.E.
*Youngstown, Ohio.

perfect and tests have shown that they could not fail, or were not likely to if they received any reasonable amount of attention, failures did occur many times with serious results. In one instance we are familiar with a hoist limit, of one of the acceptable types, failed to stop the motor with the result, the hoist cable was broken and a fatality occurred. Following the accident the motor and limit device were removed from the crane and set up in the shop under operating conditions to determine, if possible, the cause of failure, since no defect in or impairment of the equipment could be discovered following the accident. During the test the limit was brought into operation a great many times, we can say hundreds and perhaps, thousands of times without a failure to stop the hoist. All the possibilities for mistakes, such as resetting and continuing travel after the limit had been brought into action, by-passing the switch to prevent operation, etc., were considered but no explanation was found. Whether or not consideration was given to the matter of allowing the cable to wind on the drum while the switch was set for the lowering direction we cannot say, though we feel sure there was none.

The evidence is that any hoist limit device, constructed and installed in accordance with well known principles, is reliable if fairly treated as required by proper rules for operating and is properly inspected. Among the well known causes for failure of crane hoist limits are the following: Winding the cable on the drum when motor is running in the lowering direction, wrong wiring; shortening by twisting or kinking of safety cable attached to the weight that throws switch; purposely by-passing the switch, and deterioration of parts from wear and tear. In my opinion the most common of the causes is winding of the cable on drum when motor is running in the lowering direction. This occurs most often with hoists of that type, where cables are so limited the bottom block will not touch ground when at the lowest point of travel. It also, possibly, can occur in all cases where the cable can run entirely off the drum before bottom block touches ground. As most limit devices for stopping travel of crane hoists are constructed and installed the switch will not break the circuit if motor is running in the lowering direction, but the contact for throwing switch will damage it without breaking the circuit or stopping travel of the hoist. Possibly this defect in construction and installation might be remedied. If the likelihood of shortening a safety attachment to a weight for throwing the switch after stress is released from the opposite throw is foreseen, such a possibility can easily be avoided. Another common cause for failure is wrong wiring. This along with purposely by-passing the switch, and failure to inspect and test is dependent on the integrity and carefulness of operators and inspectors. We must admit there are but few operations in mill practice where efficiency is not dependent on the integrity of some employees. This being true the lack of carefulness and integrity cannot be entirely remedied by supplying protecting mechanical devices.

In some early discussions in regard to applying travel limits to crane hoists, opposition to their installation was offered by some capable superintendents on the grounds of unreliability. It was contended operators after having been given to understand their jobs were at stake would be reliable. Such argument seems to be at fault in that reliability of operators is not improved by having confidence in them, no more than is the quality of mechanical equipment. While discipline can be applied to negligent operators loss from failures cannot be restored. While we are placing confidence in operators, it seems well to have a check on their possible carelessness by employing a limit device. We must remember crane operators are forbidden to make a utility of a limit stop, yet it has been shown that in many cases the order was disregarded and, of course, no means was provided for detecting such carelessness before an accident occurred. While it is but natural to have confidence in crane operators of our own selection, it is just as important to guard against their mistakes as it is to guard against failure of a control governor on a steam engine, by employing an automatic quick closing valve. Our confidence in good installation along with reasonable inspection cannot be shaken, although we do not approve of making a utility of a limit device.

By referring to some previous discussions of mine it will be seen I have advocated supplying some sort of tell-tale device that will record when an automatic hoist limit is permitted to operate, in order to determine if the limit was unnecessarily operated. We believe there is a hoist limit on the market that is or that can be equipped with such recording attachment and, also, an attachment for ringing a gong to give audible evidence contact has been made with the limit. It seems as though such a warning device would satisfy all requirements and one should be attached to all hoist limit devices. Above all other requirements for sure operation of limits should be inspection and maintenance.

Possibly extended discussion of limit devices might lead to the importance of installing a secondary actuating device—the switch—which would be a check on the regular one by coming into action when the regular actuating device failed. This would be in accord with the principle of installing an automatic quick closing valve on a steam engine, that would prevent disaster from overspeeding when the control governor became impaired and failed to perform its office. In one particular instance we have seen the necessity for secondary equipment in order to bring the device for cutting out ignition on a gas engine into operation. Some day the necessity will be recognized for installing an additional switch on all electrically operated automatic devices for stopping engines when, through failure of the control governor they overspeed.

Summing up all the evidence ever presented to me in regard to employing limit travel devices to hoist equipment of overhead traveling cranes, my conclusion is they should be installed wherever the conditions are such that failure on the part of a crane operator to stop travel of a hoist might cause injury to persons or damage to property. Another conclusion is, many of the accidents that involve injury to persons, delay of operations and damage to property, might be avoided by a more general dissemination of information regarding construction and proper operation of limit devices, as well as particulars concerning accidents and near accidents that occur through their failures. Such information should be passed on down to crane operators and inspectors.

The Economics of Combustion†

By J. B. CRANE*

There have been innumerable articles printed showing how one engineer has designed a plant that delivers a kilowatt hour for less B.t.u. than some of other plants and that on the newest plants for 1400 lb. pressure with reheat a kilowatt hour will be delivered at the switchboard for about 12,500 B.t.u. or less than one lb. of coal. It is claimed for the mercury cycle that only about 9,000 B.t.u. will be required at the switchboard for each kilowatt hour generated.

There have been several articles printed showing how much it costs to build a power plant and how one engineer had designed a plant to cost $95.00 per kilowatt, another to cost $105.00 per kilowatt or some other figure when the plant was finally completed but at the present time, owing to installation of extra foundations, water circulating works and other things, the cost was much in excess of these figures. Possibly changes in load or affiliations with other companies would mean the plant was never completed or final completion was postponed for several years. In this case the cost of manufactured power at this plant must bear the interest and depreciation of this increased investment for all time or at least during that period until the final completion of the plant.

The papers have been few that have been presented covering the cost of power ,taking into consideration the cost of plant with its interest, depreciation, taxes and other overhead costs combined with the operating costs not because of lack of studies of this nature because practically all projects have been studied along these lines, but because engineers have either been reticent about publishing such studies or their employers have not wished such matters made public.

We are today considering only the boiler room. We can secure apparatus to operate the boiler room at almost any efficiency up to 90 per cent. Where shall we stop? What apparatus shall we install? How much shall we spend? Shall it be pulverized coal? Shall it be stokers? The answer to these questions depends upon certain characteristics of the plant, such as,

Load Factor
Cost of Apparatus
Character of Fuel
Cost of Fuel
Character of Labor
Cost of Labor
Cost of Money
Furnace Construction.

Let us first study a typical heat balance of a boiler room. The familiar one, for which you can all obtain the detailed figures is that published by D. S. Jacobus, "Tests of Large Boilers at The Detroit Edison Company," A. S. M. E., Volume 33.

†Presented before Chicago District Section, A.I.&S.E.E., February 15, 1930.

*High Pressure Steam Specialist, Combustion Engineering Corp., New York.

TABLE I
Heat Balance—Coal Firing

	B.t.u.	Percent
Heat absorbed by the boiler	10,791	77.08
Loss due to moisture in coal	25	0.18
Loss due to moisture in burning H_2	642	4.58
Loss in dry chimney gases	1,616	11.54
Loss due to moisture in air	39	0.28
Loss due to incomplete combustion of C	227	1.62
Loss due to unconsumed C in ash	323	2.31
Radiation and unaccounted losses	337	2.41
	14,000	100.00

These tests have been accepted as being quite accurate. The question of temperatures in a boiler test can be quite far from the mark especially on wide boilers. The temperatures at different points across the setting may vary 20 per cent and even at the same point may vary as much as this at fairly close intervals of time. They may be too low due to the placing of thermometers or thermo-couples too close to the absorbing surface. Similar errors may result due to improper sampling of the flue gases. Dr. Jacobus considered all these factors in making the above tests.

It will be noted that no deductions are made for fan power. These boilers are operated with natural draft. As we add economizers and air preheaters the draft loss becomes too great for natural draft stacks and induced draft fans become necessary. The increased power taken by the fans may counteract the increased efficiency secured by longer economizers and air preheaters.

In looking over the heat balance shown in Table I to see where the savings can be effected, we find the CO_2 was 14 per cent at the outlet of the boiler. This cannot be bettered very much as this represents good operation with either pulverized coal or stokers. Consequently the weight of gases remains the same except for any increase of efficiency which may be obtained.

The exit temperature in this case was 575 deg. fahr. With economizer and air preheater this may be reduced to 220 deg. fahr. It is much better to have around 300 deg. fahr. at maximum rating or other wise at low rating the exit temperature will be below the dew point and corrosion will occur on the air preheater or the gas side of the economizer if there be no air preheater.

Let us reconstruct the heat balance on the basis of an exit temperature of 220 deg. fahr.

TABLE II
Heat Balance (Reconstructed)

	B.t.u.	Percent
Heat absorbed by boiler	12,189	87.00
Loss due to moisture in coal	21	0.08
Loss due to moisture formed in burning H_2	555	3.93
Loss in dry chimney gases	440	3.12
Loss due to moisture in air	33	0.22
Loss due to incomplete combustion of C	195	1.66
Loss due to unconsumed C in ash	278	1.96
Radiation and unaccounted losses	289	2.03
	14,000	100.00

It will be seen that even with the low exit gas temperature of 220 deg. fahr., further savings must be made to secure 90 per cent efficiency. This will have to be done through more complete combustion and less radiation losses. The loss through hydrogen being burned to H_2O should be noted. For some gases this may amount to more than with coal. A study of this heat balance will show that anybody reporting efficiencies in excess of 90 per cent has some special conditions to offer in explanation.

LOAD FACTOR

The load factor is the ratio of the maximum load to the average load. This is open to many interpretations. The maximum load may be taken as the peak capacity of the equipment but is usually referred to as the maximum peak on the station for at least one hour. There may be special cases where the load is widely fluctuating where some percentage of maximum instantaneous peaks may be taken. The average load may be the hourly load for a day, a week, a month or a year in which case the ratio would be the hourly, daily, weekly or yearly load factor as the case may be. We usually refer to the yearly load factor. If a plant operates on a steady load 8760 hours per year with no peak above the average load, the load factor would be 100 per cent. Many industrial plants operate eight hours per day, 300 days per year and assuming no peak in excess of the average load, the load factor would be about 27 per cent. The actual load factor would probably be somewhere between these points.

Assume a plant turning out 100,000 lb. of steam per hour and that such a boiler plant cost $175,000. Assume overhead charges of 17 per cent to cover interest, depreciation and taxes.

TABLE III
Overhead Costs of Steam per Hour

	Load Factor Percent 100	27
Cost of Plant	$175,000	$175,000
Fixed charges per year	29,800	29,800
M. lb. of steam per year	876,000	240,000
Cost cents per M. lb. of steam	3.4	12.4

To this must be added the fuel and labor. Assuming the same efficiency the fuel cost per M. lb. of steam would be the same except for additional fuel for starting and stopping fires and for banking in case of the low load factor. Labor costs would also be a little higher per M. lb. of steam in case of the low load factor because of extra labor during periods of shut down. On an evaporation of 11 lb. of water per lb. of coal and $4.00 per ton, the fuel cost per M. lb. of steam in the two cases allowing two per cent for banking, etc., in the case of low load factor would be 19 cents for 100 per cent load factor and 19.4 cents in the case of low load factor.

If we increased the efficiency 3 per cent by the investment of the $25,000 we would add ½ cent to the cost of steam per M. lb. at 100 per cent load factor and 1.8 cents per M. lb. on the low load factor and would save per year on increased efficiency 0.6 cents per M. lb. of steam. In the case of the high load factor this would amount to a reduction in the fuel bill of $5,256.00 and in the case of low load factor only $1,440.00. This illustrates the effect of load factor and cost of apparatus on the situation.

CHARACTER OF FUEL

This has a great deal to do with the design and cost of the plant. The plant may be located adjacent to a supply of good Eastern Bituminous coal. A well designed stoker job may be the answer. The plant may be near a constant supply of mid-west coal. Here again a stoker of another design may be the most economical.

If the supply of coal is to vary and gaseous or liquid fuels are obtainable at times, then pulverized fuel will probably be the best solution.

COST OF FUEL

This has considerable effect on the economics of the situation. Assume the use of 100,000 tons of coal per year. Each increase of $1.00 per ton in the cost of fuel means an increase of $100,000 per year. Three per cent on $400,000 means $12,000 per year, while it is only $3,000 on coal at $1.00 per ton.

CHARACTER AND COST OF LABOR

This does not have as much effect as formerly. Up to a few years ago the employers were unwilling to provide proper labor for the boiler plant. They formerly thought anybody could shovel coal; instruments might be all right in the turbine room to measure amperes, volts and watts but the boiler man only needed a steam gage and a water level indicator. The steam gage might even be omitted as the safety valves would open if the pressure became too high. Today this has changed and draft gages, temperature recorders, steam flow meters are common and no new power plants are built without such instruments. Flue gas instruments are as common as engine indicators used to be and their use is understood by the majority of operators. With the advent of automatic firing equipment, fewer and better men have been employed in the boiler room.

In a modern study, care is always given to the number of operators required. By relocating fans or pumps and locating instruments and other equipment properly, one or more operators per shift can be done away with and each man omitted saves $6,000.00 or more per year for the three shifts. This pays for some additional expense in the original installation.

COST OF MONEY

This has a large effect on the type of equipment and first cost of the installation. Some of the varying percentages used are shown below.

Interest	5 to 8 percent
Depreciation	5 to 6 percent
Taxes	2 to 3 percent
Total	12 to 17 percent

In certain plants there are places where money can earn 20 to 30 per cent by installing more modern machinery or new methods of manufacture and the owner cannot justify installing economizers or air preheaters until all such work is out of the way. With higher pressures the boilers are not as efficient. The exit temperature from the boiler is affected by the temperature of the water in the boiler. At 200 lb. pressure the water temperature is 388

deg. fahr. and the exit temperature may be 500 deg. fahr. With the same boiler at the same rating operating at 450 lb. pressure the water temperature is 460 deg. fahr. and the exit gas temperature would be 572 deg. fahr. The reason for the higher pressure is to secure better operating efficiency in the turbine room and the higher exit temperature can be reduced by economizers, air preheaters or larger boilers.

FURNACE CONSTRUCTION

This part of the combustion equipment has undergone more rapid changes than anything else. In designing a steel structure an engineer finds out the limitations of the materials to be used and builds the structure with these limitations in mind. If the structure fails the engineer is to blame. In building furnaces with refractory materials very little information was available and if the structure failed the materials were to blame. Today we know refractory materials are limited as to the temperature they will stand, especially under pressure. We have developed air-cooled refractory furnaces and water-cooled furnaces.

The limitations of each are shown in the following table, based on the use of pulverized coal.

TABLE IV

Permissible Rates of Heat Release

Type of Furnace Wall	B.t.u. released per cu. ft. of furnace volume
Solid Refractory	11,500 to 14,000
Air Cooled Refractory	13,000 to 20,000
Water Cooled	17,000 to 30,000

The figures given in Table IV are on the basis of continuous twenty-four hour operation and are effected by fuel used, method of firing as well as fineness of pulverization. Some installations are using higher combustion rates but it will be usually found there are some special features affecting the situation.

It has been popularly supposed that refractory furnaces were necessary to burn properly low volatile fuels and blast furnace gas. Two years ago two units, with completely water-cooled walls, were installed to burn blast furnace gas, but with the fuel introduced at the four corners to provide the maximum of turbulence for the proper mixing of air and gas. These furnaces have been unusually successful in spite of many dire predictions as to their failure. The same company is installing four more units similarly fired.

To show how different designers may attack the same problem today, I have shown two figures. Figure 1 illustrates the familiar curve of temperature of gases versus heating surface. If the temperature of liquid in the boiler is 500 deg. fahr. we can never get the exit gas temperature down to this point except by the installation of infinite surface. In boiler work the economic point was 100 to 150 deg. fahr. above this temperature. Today with the use of economizers and air preheaters the economic point for the boiler may be 400 or 500 deg. fahr. above the temperature of the water in the boiler. By treating the economizer the same way, that is by having the gases enter at a higher temperature and leave at a higher temperature, we will obtain a higher heat head and a greater rate of heat transfer in the economizer. The economizer will be smaller. The air preheater will respond to the same sort of treatment. In Figure 2 are illustrated two designs to accomplish the same result, one along the lines above stated, the other using a larger boiler and installing

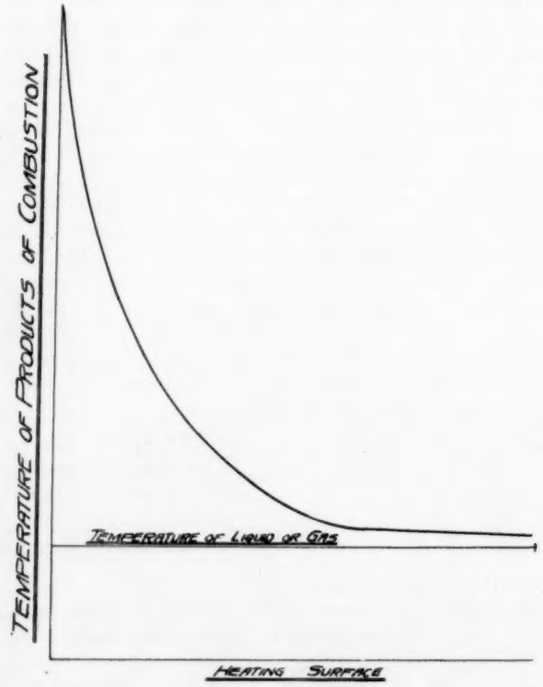

FIGURE 1
TYPICAL CURVE SHOWING REDUCTION IN TEMPERATURE OF THE PRODUCTS OF COMBUSTION VS. HEATING SURFACE

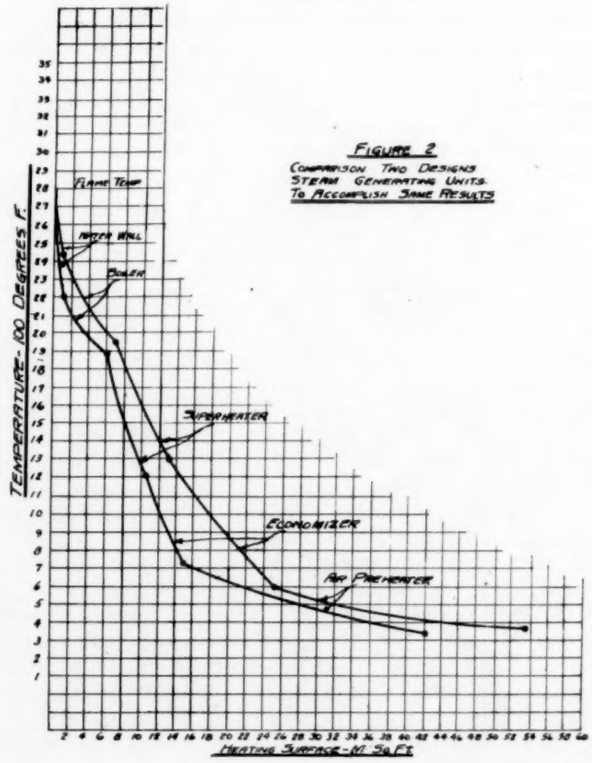

FIGURE 2
COMPARISON TWO DESIGNS STEAM GENERATING UNITS TO ACCOMPLISH SAME RESULTS

an economizer which reduces the exit temperature below the economic point. The first requires 42,000 sq. ft. of heating surface. The second requires 53,000 sq. ft. of heating surface. It should be remembered that any completed design should be studied for water storage, steam relieving space and steam volume for dry steam, steam circulation to see that there are no places that will be overheated due to lack of proper water supply. With the multiplicity of pressures to choose from and a careful study of the various designs that can be adopted, the position of the combustion engineer has become more complicated but intensely more interesting. The question of standardization is still to be solved and its final solution seems to be something for the future to determine.

Crane Track Wheels†

By E. S. SAWTELLE*

We manufacture crane track wheels from forged and rolled steel blanks, when it is possible to obtain a forged and rolled steel blank suitable for sizes specified.

Tread and flanges are hardened to a depth of approximately 3/16" allowing sufficient tough center to back up the hardened wearing face and eliminate flange breakage.

The original contour of tread and flange is maintained for an indefinite period, being so hard it will not pick up grit. This reduces friction, and being of a different carbon from the rail, instead of wearing, tends rather to prolong the rail life.

Tapered Tread Bridge Wheels: The method of putting a taper tread on the drivers for bridge wheels has recently been much discussed. We had our first test put out in 1925 and now have a considerable number of companies that are giving additional tests. Thus far the taper tread wheels are giving very satisfactory results.

By tapering the tread of the drivers 5/8" per foot, one wheel left hand and the opposite wheel right hand taper, a side movement of the wheel 1/8" changes the wheel circumference .041". This amount doubled for displacement of opposite wheel to plus or minus diameter gives .082" in circumference variation. It is usually customary on a taper tread wheel to make the tread face of the wheel wider than standard to give possibilities for enlarged taper tread and self aligning action.

In addition to compensating for variation in tread diameters the taper tread method seems to eliminate crane misalignment and reduce flange wear to a minimum. Obviously with a taper tread wheel it is desirable to have the highest possible quality of wheel so that wear will be minimized on the tread and the taper tread feature will be maintained theoretically correct for as long a period of time as possible.

Wheel diameters: Wheel diameters have a decided effect upon their ability to withstand loads, likewise upon their digging in to the rail and thereby causing a rolling action against the rail. To determine more definitely the effect of diameters and contours, we have run a series of checks on 18", 24", and 30" wheel on an 80 lb. ASCE rail. Wheels of different contours were placed upon the rail, rigidly mounted under a hydraulic press, and subjected to pressures up to 200,000 lbs. Measurements were taken from the hub of the wheel to the foundation of the rail to ascertain the amount that the wheel embedded itself in the rail and the rail in the wheel under varying pressures. From these tests the following conclusions were drawn:

1. For equal pressure the larger the diameter of the wheel the less it embeds in the rail. An 18" wheel embeds itself from 10% to 15% deeper than a 30" wheel at low pressures, and 5 to 10% less at high pressures.
2. A flat tread or taper tread wheel embeds itself into the rail about 25% deeper than the radius tread wheel which more nearly fits the rail shape.
3. Tests comparing Tool Steel wheels with high carbon untreated wheels showed that while the Tool Steel wheel showed a slightly greater amount of apparent embedding than the high carbon wheel, the impression left in the rail was only about half, as deep. This is explained by the fact that there is more flexibility in the Tool Steel wheel because of its softer center and it tends to spring a trifle, enlarge the area of contact without digging in deeper at a localized point. This should be decidedly beneficial for rail wear.

While the wheels under high pressure make a very definite impression on the wheels, there is no impression left on the wheel that can be measured. Fig. 1.

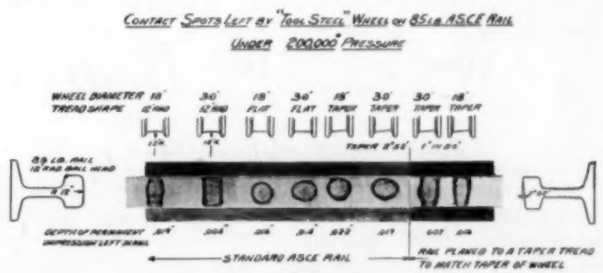
CONTACT SPOTS LEFT BY "TOOL STEEL" WHEELS ON 85 LB. A.S.C.E. RAIL
UNDER 200,000 PRESSURE
WHEEL DIAMETER 18" 30" 18" 30" 18" 30" 30" 18"
TREAD SHAPE 12 RAD FLAT TAPER TAPER TAPER TAPER TAPER
STANDARD A.S.C.E. RAIL
RAIL PLANED TO A TAPER TREAD TO MATCH TAPER OF WHEEL

FIG. 1.

In comparing the action under pressure of a taper tread wheel on a taper rail and the same wheel on a standard ball rail, it was found that the impression left on the ball rail was approximately twice as deep as that left upon the taper rail where there was approximately line contact.

Wheel Loads and Size of Rails: Over the past few years, speeds, spans and loads of cranes have

†Presented before Pittsburgh District Section in connection with Crane Discussion, January 16, 1930.

* V. P. and Gen. Mgr., Tool Steel Gear & Pinion Co., Cincinnati, Ohio.

been materially increased, whereas in some cases the size of track wheels and rails have not been increased to take care of the heavier loads. There has resulted an increase in maintenance costs. The above conditions apply not only to new equipment, but also to old cranes which have been revamped by increasing the weight of girders and speeding up to take care of present day mill conditions.

Allowable wheel loads are affected seriously by a number of conditions, some of which are the following:

(a) Total weight of the crane and the load.

(b) A runway that is not kept straight, tight, and in order may cause vibration in the crane that will be seriously detrimental to wheels.

(c) A smooth runway with rails welded gives better action than where the rails are spaced and the crane bumps over the joints.

(d) Building construction that may be influenced by heat or cold sometimes causes misalignment in the rails leading to flange pressures, flange wear, and tending toward tread stretching.

(e) In certain installations such as soaking pits, work is often all done on one side of the craneway throwing abnormal loads on these wheels, and a comparatively light load on the opposite wheel.

(f) A crane operating in the weather and encountering wind loads, icy rails, and similar conditions must have larger factors than in normal operation.

(g) Speed is a tremendous factor in permissible wheel loads, since rapid starting and rapid stopping tends towards slipping and skidding of the wheels; some of our modern high speed cranes operating at speeds of 385 to 700′ per minute should have 25 to 50% larger wheel capacity than cranes of normal operation.

We would offer as a suggestion for present operation the following table for maximum safe loads; we consider this table decidedly conservative and we know of many cases where wheels are operating far over capacity and giving satisfactory results. This table represents a general average and if cranes are operated in severe duty or under bad alignment, etc., this should be taken into consideration.

Wheel Diam. Inch	Flange Thick. Inch	Throat Thick. Inch	Rail lb.	Max. Safe 250-380 F.P.M	Wheel Load 385-700 F.P.M.
12	1	1-¼	40	15700	11775
12	1-¼	1-½	50	17800	13300
12	1-½	2	60	20000	15000
14	1	1-¼	40	18800	14100
14	1-¼	1-½	50	20750	15600
14	1-½	2	60	23250	17500
16	1	1-¼	40	21000	15750
16	1-¼	1-½	50	23750	17800
16	1-½	2	60	26500	19900
18	1	1-¼	40	23500	17600
18	1-¼	1-½	50	26750	20000
18	1-½	2	60	30000	22500
20	1	1-¼	50	29750	22300
20	1-¼	1-⅞	60	33000	24750
20	1-½	2-¼	80	35000	26250
24	1-¼	1-¾	60	40000	30000
24	1-½	2-¼	80	42000	31500
24	1-¾	2-½	100	46000	34500
27	1-¼	1-¾	60	45000	33750
27	1-½	2	80	47000	35250
27	1-¾	2-½	100	59000	44250
27	2	3	130	65000	48750
30	1-¼	1-¾	60	50000	37500
30	1-½	2	80	52500	39250
30	1-¾	2-½	100	66000	49500
30	2-¼	3-½	150	75000	56300
33	1-¼	1-¾	60	55000	41250
33	1-½	2	80	57500	43000
33	1-¾	2-½	100	72500	54250
33	2	3	130	79000	59250
33	2-¼	3-½	150	83000	62250
36	1-¼	1-¾	60	60000	45000
36	1-½	2	80	63000	47250
36	1-¾	2-½	100	79500	59500
36	2	3	130	86500	65000
36	2-¼	3-½	150	90000	67500

We do not pretend to offer these tables as perfect nor as tables that will cover the various materials and treatments in wheels now being used. We believe, however, from the standpoint of safety and maintenance the question of wheel loads and size of rails are sufficiently important to justify a thorough investigation by the Association of Iron & Steel Electrical Engineers. We offer these tables to give something to start the discussion.

Items of Interest

PERSONNEL CHANGES

John Bode, recently identified with the Wellman Engineering Company, Cleveland, has become associated with the sales department of the Aetna-Standard Engineering Company, Youngstown. Before going with the Cleveland company, Mr. Bode was engineer of the Mackintosh-Hemphill Company, Pittsburgh.

F. E. Harrell has been appointed engineer in charge of drafting and experimental departments of the Reliance Electric & Engineering Company, Cleveland, O., manufacturers of alternating-current and direct-current motors.

Mr. Harrell started with the Reliance organization in 1924 after graduation from Purdue University in electrical engineering. He spent two and one-half years in sales and then was transferred to the engineering department. Here he worked until his recent promotion.

H. W. Reed is works manager of Shaw Crane Works at Muskegon, Mich., of Manning, Maxwell & Moore, Inc., New York. He succeeds Henry Huss, recently resigned. Others who are identified with the administration of the plant are: John Minty, chief engineer; J. L. Haga, estimating engineer; J. C. Harth, assistant chief engineer, and Gail Maze, assistant estimating engineer.

John Kelly, Jr., formerly with the Association of Iron and Steel Electrical Engineers, is now connected with the Schloemann Engineering Company, Empire Building, Pittsburgh, Pa.

A. B. Harper, who has been connected with the Carnegie Steel Company, Pittsburgh, for 25 years, for the past 13 years as assistant manager of sales in the Detroit district, has become affiliated with the Bopp Steel Corporation, Detroit, manufacturer of cold rolled strip steel. Mr. Harper will be connected in an executive capacity with the company's new mill to be placed in operation early in April, assisting A. J. Bopp in the sales department.

E. R. Norris has been appointed assistant to vice president according to an announcement issued by J. S. Tritle, vice president in charge of manufacturing of the Westinghouse Electric and Manufacturing Company. Mr. Norris, formerly general works manager, will now be responsible for all plant facilities of the company, manufacturing methods, cost reduction and inspection. Mr. Norris has been associated with the Westinghouse company since 1892.

F. H. Willcox, vice president of Freyn Engineering Company, returned from Europe March 4, on the Ile de France. Mr. Willcox has been abroad in connection with the blast furnace plant which is being designed by Freyn Engineering Company for the Ford Motor Company and which is to be built at Dagenham, England.

R. H. McCredy has become connected with the Harnischfeger Sales Corporation of Milwaukee, Wis. He will be employed in an executive sales capacity with headquarters at 50 Church street, New York City.

At the mid-March meeting of the board of directors of the Allegheny Steel Company four new vice presidents were elected from among the executive officers of the company. They are V. B. Brown, who has been assistant to the president; W. F. Detwiler, general manager; F. H. Stephens, who is also secretary and assistant treasurer, and P. F. Voight, Jr., general sales manager, who becomes vice president in charge of sales.

C. Brigham Allen, Jr., has been appointed district sales representative of the Philadelphia office of the Reliance Electric & Engineering Company, Cleveland, manufacturers of alternating and direct current motors.

An order received by Westinghouse Electric and Manufacturing Company, East Pittsburgh, from Carpenter Steel Company, Reading, Pa., calls for most of the equipment required to electrify its merchant bar mills. This consists of six direct-current motors (two 600 horsepower, two 750 horsepower, and two 1000 horsepower), two 100 kilowatt motor-generator sets, and switching and control apparatus. This equipment will eliminate a half-mile carry of steam across the Schuylkill River.

S. H. Pittman has been appointed Manager of the Sales Promotion Section, Domestic Appliance Department, Westinghouse Electric & Manufacturing Company. His headquarters will be in Mansfield, O.

Wilfred Sykes has been appointed assistant to the President of the Inland Steel Company in charge of operation with headquarters at the company's Chicago offices. He succeeds the late David P. Thompson.

Mr. Sykes has been Assistant General Superintenof Inland's Indiana Harbor Works since 1927. He first came to Inland in 1923 in charge of new construction work. Prior to that time he was with the Steel & Tube Company of America for two years and with the Westinghouse Electric & Mfg. Company for eleven years.

James H. Walsh has been elevated from the position of General Superintendent of Inland Steel Company's Indiana Harbor Works to Works Manager of that plant. Mr. Walsh has served as General Supernitendent since 1927 and was Assistant General Superintendent since 1922. Prior to that time he was employed at the South Chicago Works of the Illinois Steel Company for 22 years.

Henry R. deHoll succeeds Mr. Walsh as General Superintendent. Mr. deHoll has been associated with Inland since 1913, first as Superintendent of the Coke plants and more recently in charge of blast furnaces and Coke plants. He was formerly with the Republic Iron and Steel Company, Birmingham, and the Tennessee Coal, Iron and Railroad Company, Birmingham.

Frederick M. Gillies replaces Mr. Sykes as Assistant General Superintendent. Mr. Gillies first came to Inland in 1922 as Superintendent of the 100" Plate Mill, and has been in charge of several rolling mills at Inland's Indiana Harbor Works since 1927. He is a graduate of Cornell University and was formerly in the employ of the Illinois Steel Company.

Other new appointments at Inland's Indiana Harbor Works include: C. A. Brassert, Superintendent of the 100" Plate Mill; H. W. Johnson, Superintendent of Blast Furnaces; T. F. Plimpton, Assistant Superintendent of Blast Furnaces; T. J. Gardner, Superintendent of Coke Plants; C. L. Corban, Assistant Superintendent of Coke Plants.

WITH THE MANUFACTURERS

At the annual meeting of shareholders March 14, 1930, the name of The Ohio Electric Manufacturing Company was adopted in place of the former name, The Ohio Electric & Controller Company.

Freyn Engineering Company, Chicago, Ill., has been awarded the contract for two 160 ft. Dorr Thickeners, complete with all auxiliary equipment which are to be installed for the recovery of flue dust from the wash water of the blast furnace in one of the largest steel plants in the Chicago district.

The Electric Machinery Manufacturing Company of Minneapolis, Minn., announces the new location of their Baltimore office. Formerly at 432 North

Calvert street, the Baltimore office will now be located at 600 North Calvert street.

Bethlehem Steel Company has contracted with the Freyn Engineering Company for five Mathesius Hot Blast Valves to be used in connection with hot blast stoves being built at Johnstown, Pa.

Sloss-Sheffield Steel & Iron Company, Birmingham, Ala., have purchased from Freyn Engineering Company, two Freyn-Design Continuous Stock-Line Recorders for use at its city furnaces.

The Nuttall Works of the Westinghouse Electric & Manufacturing Company in Pittsburgh, Pa., recently completed a double reduction gear unit for driving rolls in a steel mill at Leechburg, Pa.

The unit transmits power from a 1600 h.p. motor running at 705 r.p.m., through two sets of gears having a ratio of 14 to 1. For the first reduction two sets of helical gears are used. These are mounted one at each end of the high and intermediate speed shafts. Between the helical gears on the intermediate shaft is the pinion which drives the slow herringbone gear. Sleeve bearings are used throughout. All rotating parts are lubricated by a splash system. This unit is capable of developing more than two million inch-pounds of torque at the low speed shaft. The total weight including flywheels is about forty tons.

Three other units of single reduction type were also built for the same mill. These were each for use with 800 h.p. motors running from 275 and 688 r.p.m. Ratios of these units are 1.83 to 1, 2.5 to 1 and 3.67 to 1.

The annual meeting of the American Refractories Institute will be held at White Sulphur Springs, W. Va., May 19 and 20.

The twenty-third revised and enlarged edition of "Arithmetic of Electricity," by Prof. T. O'Conor Sloane, is just off the press. This book reduces electrical calculations to a series of rules, involving only ordinary arithmetic. The publisher is the Norman W. Henley Publishing Company of New York.

The Ventilating Equipment Corporation, Bessemer Building, Pittsburgh, Pa., a recently formed Company, with Mr. M. R. Robinson, President and Mr. J. D. Reed, Treasurer, will handle the accounts in the Pittsburgh District of the American Air Filter Company, which is a consolidation of what was formerly the Reed Air Filter Company, National Air Filter Company and Midwest Air Filter Company. They are also representing the Clarage Fan Company, Nichols Products Corporation and DeBothezat Impeller Company in the same territory.

A new line of "trip-free" air circuit breakers has been placed on the market by the General Electric Company. The principal advantages of these breakers are: They are trip-free from the handle on overcurrent; there is triple contact; there is no burning on the main brush; the burning tips are easily replaced; the high pressure main contact is formed of laminations which make "end-on" contact with heavy and uniform pressure, and yet is closed easily with a wiping motion and they have low operating temperature. The breakers are available for either instantaneous or time delay automatic operation in either single, double, or triple-pole combinations with necessary accessories. A high-grade finish makes them particularly applicable on building equipment switchboards.

There are three classifications of breakers for voltages of 650 volts and below: the type CN-1 is a compact breaker applicable to industrial service and for circuits in buildings where the current is from 3 to 300 amperes. The type CP-108 is a breaker for moderate duty service rated 1200 amperes and below. The type CK-8 is a heavy-current breaker for moderate or heavy duty service ranging from 1600 amperes up.

Reliance Electric & Engineering Company, Ivanhoe Road, Cleveland, O., are distributing Bulletin No. 106, a 16-page booklet and describes their Type AA Reliance Induction Motors. The bulletin may be obtained by writing the above company.

"Successful Canadian Pumping Station" are illustrated, described and listed on a map in a 28-page leaflet issued by the De Laval Steam Turbine Company, Trenton, N. J. Because of the extensive development of hydro-electric power in Canada, many of these stations employ motor driven pumps, in some cases, supplemented by gasoline engine driven standbys. Some of the larger plants, however, as in Toronto, are equipped with geared steam turbine driven pumps, while a few derive their motive power from hydraulic turbines. A number of the electrically driven pumping units have shown over-all efficiencies from water to water of 86 per cent and over, one having reached 87.2 per cent on the official test. Large scale sectional drawings point out improved features of design in the several classes of centrifugal pumps adapted for water works and industrial service.

STATEMENT OF OWNERSHIP, MANAGEMENT, ETC., OF
IRON AND STEEL ENGINEER
(Required by Act of Congress of August 24, 1912)

Name of Publication: Iron and Steel Engineer, published monthly at Pittsburgh, Pa. (Report of April 1, 1930.)
Editor—John F. Kelly, Empire Bldg., Pittsburgh, Pa.
Business Manager—John F. Kelly, Empire Bldg., Pittsburgh, Pa.
Names and addresses of stockholders holding 1 per cent or more of total amount of stock: None.

Board of Directors

President, F. W. Cramer, Republic Iron and Steel Co., Youngstown, O.
First Vice President, R. M. Hussey, Jones & Laughlin Steel Corp., Aliquippa, Pa.
Second Vice President, F. O. Schnure, Bethlehem Steel Co., Sparrows Point, Md.
Treasurer, James Farrington, Wheeling Steel Corp., Steubenville, O.
Secretary, W. E. Miller, Bethlehem Steel Company, Johnstown, Pa.
Past President, C. S. Proudfoot, Vanadium Corp. of America, Niagara Falls, N. Y.
Past President, A. J. Standing, Bethlehem Steel Company, Bethlehem, Pa.
Director at Large, S. S. Wales, Carnegie Steel Company, Pittsburgh, Pa.
Director, F. E. Leahy, Youngstown Sheet & Tube Company, Youngstown, O.
Director, Walter Greenwood, Youngstown, O.
Director, G. A. Lamberton, National Tube Company, Lorain, O.
Director, L. C. Edgar, Carnegie Steel Company, Braddock, Pa.
Director, J. J. Booth, National Tube Company, Gary, Indiana.
Director, Geo. Pfeffer, Florence Pipe Foundry & Machine Co., Florence, N. J.
Director, E. P. Winters, Sloss Sheffield Iron & Steel Co., Birmingham, Ala.

Known bondholders, mortgagees and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages or other securities: None.

JOHN F. KELLY, Editor.
Sworn to and subscribed before me this 26th day of March, 1930.
HENRY S. BEPLER, Notary Public.
(My commission expires March 6, 1931.)

RAYMOND ROLLER MILLS

18,250,000 TONS OF COAL

per year is the capacity of Raymond Roller Mills installed in power plants of the United States—or 40% of the total coal consumed by the Central Station Industry in 1929.

The Central Stations Listed Below Are Among Those Which Depend Upon Raymond Roller Mills for Their Pulverized Coal

Alabama Power Company
Birmingham, Ala.
Gorgas Station

City of Detroit
Detroit, Michigan
Mistersky Station

Cleveland Elec. Illuminating Co.
Cleveland, Ohio
Lakeshore Station
Avon Station
20th Street Station
Ashtabula Station

Comal Power Company
San Antonio, Texas
Comal Station

Consolidated Gas, E. L. & P. Co.
Baltimore, Md.
Gould Street Station

Delaware River Mfg. Co.
Penns Grove, N. J.
Deepwater Station

Detroit Edison Co.
Detroit, Michigan
Trenton Channel Station

Duke Power Company
Charlotte, N. C.
Buck Steam Station

Duquesne Light Company
Pittsburgh, Pa.
Colfax Station

Illinois Electric Power Co.
Peoria, Ill.
Peoria Station

Metropolitan Power Company
Middletown, Pa.
Susquehanna Station

The Milwaukee Elec. R'y & Lt. Co.
Milwaukee, Wisconsin
Lakeside Station

Montaup Electric Company
Fall River, Mass.
Somerset Station

Narragansett Electric Company
Providence, R. I.
Eddy Street Station

New Jersey Power & Light Co.
Dover, N. J.
Holland Station

New York Edison Company
New York, N. Y.
East River Station

Public Service Co. of Colorado
Denver, Colorado
Valmont Station

St. Paul Gas Light Company
St. Paul, Minn.
Island Station

Sioux City Gas & Electric Co.
Sioux City, Iowa
Big Sioux Station

Texas Power & Light Co.
Dallas, Texas
Trinidad Station

Union Electric Light & Power Co.
St. Louis, Mo.
Cahokia Station

COMBUSTION ENGINEERING CORPORATION

200 Madison Avenue **New York, N. Y.**

Boilers - Air Preheaters - Stokers - Pulverized Fuel Equipment - Water-Cooled Furnaces

CHICAGO DISTRICT SECTION

EXECUTIVE OFFICERS

1929 — 1930

EDWARD C. MARSHALL,
Executive Committeeman.

G. T. HOLLETT,
Executive Committeeman.

FRED W. ACKER,
Chairman.

ARTHUR J. WHITCOMB,
Secretary.

The Chicago District Section includes in its membership most of the prominent Steel Mill Engineers in the Mid-Western territory. Meetings are held monthly at the Press Club, Chicago, Illinois.

JAS. L. MILLS,
Executive Committeeman.